POWER

Vol. 46 NEW YORK, DECEMBER 18, 1917 No. 25

A WAR OF ENGINEERS

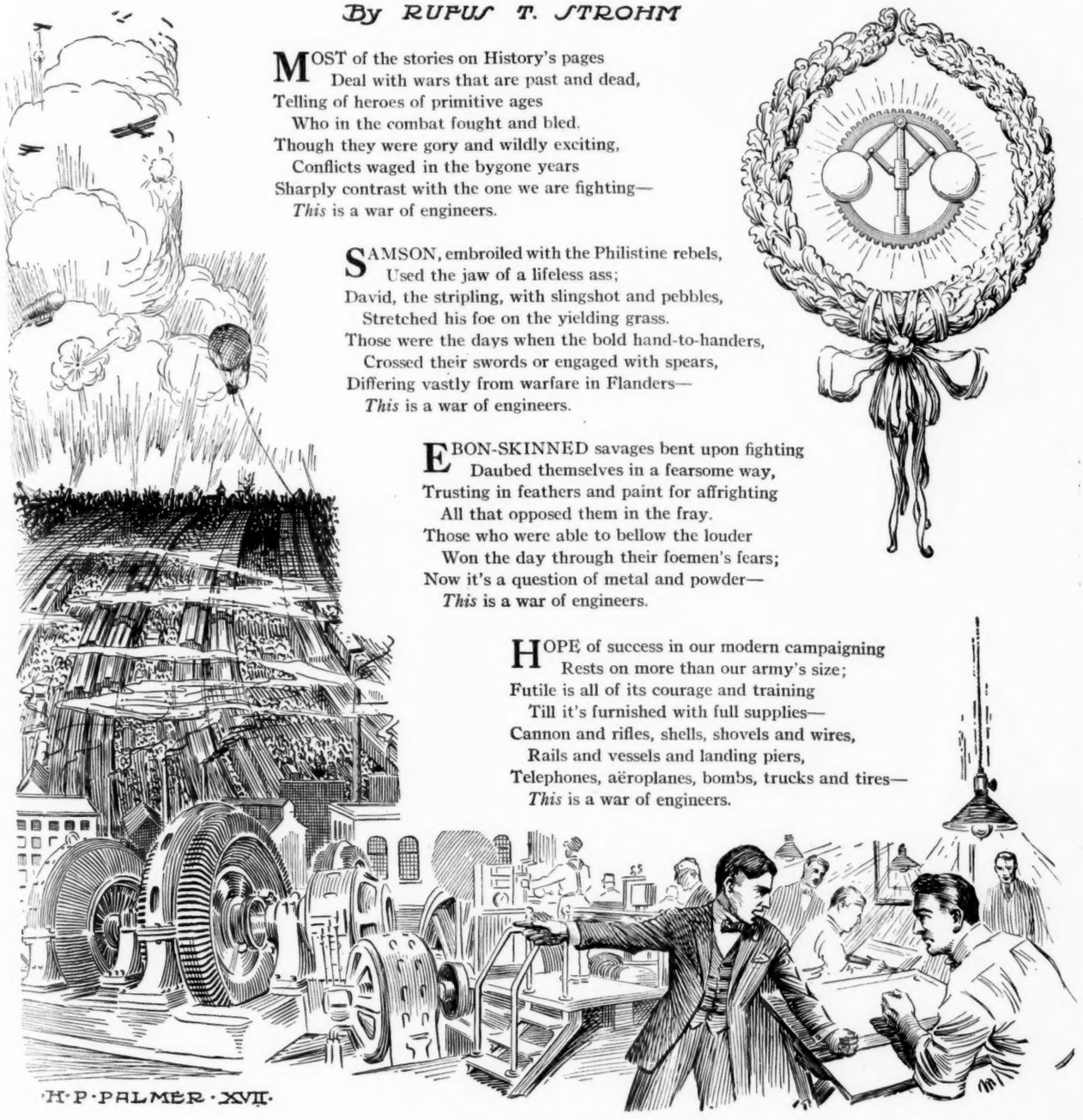
By RUFUS T. STROHM

MOST of the stories on History's pages
Deal with wars that are past and dead,
Telling of heroes of primitive ages
Who in the combat fought and bled.
Though they were gory and wildly exciting,
Conflicts waged in the bygone years
Sharply contrast with the one we are fighting—
This is a war of engineers.

SAMSON, embroiled with the Philistine rebels,
Used the jaw of a lifeless ass;
David, the stripling, with slingshot and pebbles,
Stretched his foe on the yielding grass.
Those were the days when the bold hand-to-handers,
Crossed their swords or engaged with spears,
Differing vastly from warfare in Flanders—
This is a war of engineers.

EBON-SKINNED savages bent upon fighting
Daubed themselves in a fearsome way,
Trusting in feathers and paint for affrighting
All that opposed them in the fray.
Those who were able to bellow the louder
Won the day through their foemen's fears;
Now it's a question of metal and powder—
This is a war of engineers.

HOPE of success in our modern campaigning
Rests on more than our army's size;
Futile is all of its courage and training
Till it's furnished with full supplies—
Cannon and rifles, shells, shovels and wires,
Rails and vessels and landing piers,
Telephones, aëroplanes, bombs, trucks and tires—
This is a war of engineers.



The Logan, West Virginia, Power Plant

This power station, with a capacity of 2000 boiler horsepower, has with an addition of boiler equipment supplanted 14,000 boiler horsepower at surrounding coal mines. A total load of 21,000 kw.-hr. was shortly after the starting up of the plant carried by one 500-hp. boiler for 24 hours, the day load averaging 1500 kw.-hr. This one 500-hp. boiler did the work of 4100 hp. of isolated mine boilers as formerly operated.

ONE of the most up-to-date small-capacity power plants in West Virginia, the property of the Logan County Light and Power Co., is situated at Logan. This plant furnishes power and light for about 75 per cent. of the mining operations in Logan and Boone Counties and carries the load at about one-fifth the amount of boiler horsepower that was formerly required with their individual plants.

The power station is on the Guyandotte division of the Chesapeake & Ohio Ry. and close to the Guyandotte River, the water of which fortunately is not impregnated with acid from the mines and, most fortunate of all, it does not contain scale-forming properties; therefore the periodical examinations of the boilers are carried on without the necessity of boring out scaled tubes.

Taken as a modern power plant, it is a small one, there being at present but two 4000-kw. turbines (Fig. 1), 80 per cent. power factor. They are, however, operated with a power factor of 92 per cent. A third unit of 5000 kw. capacity will be installed about the first of the year, the foundation having already been built. An addition to both the turbine and boiler rooms is being constructed.

All auxiliary equipment is of standard design and arranged in accordance with general power-plant practice. The two condensers are in the basement. Each contains 9000 sq.ft. of cooling surface, giving 2.25 sq.ft. per turbine kilowatt output, normal rating, which is large enough to provide ample capacity for heavy turbine overloads. As the circulating pump delivers 8000 gal. per min. to the condensers, with a turbine steam consumption per kilowatt-hour of 12.6 lb., as shown by the steam-flow meter, there would be condensed at full normal load 50,400 lb. of steam, requiring at full pump capacity 6.3 gal., or 52.4 lb., of circulating water per pound of steam. Condensing water is obtained from the river that flows past one end of the plant, Fig. 2. At present débris is prevented from entering the intake by stationary screens, but owing to the quantity of floating leaves, etc., a set of revolving screens will soon be put in. Both circulating pumps, each driven by a 75-hp. induction motor, are placed above the intake tunnel.

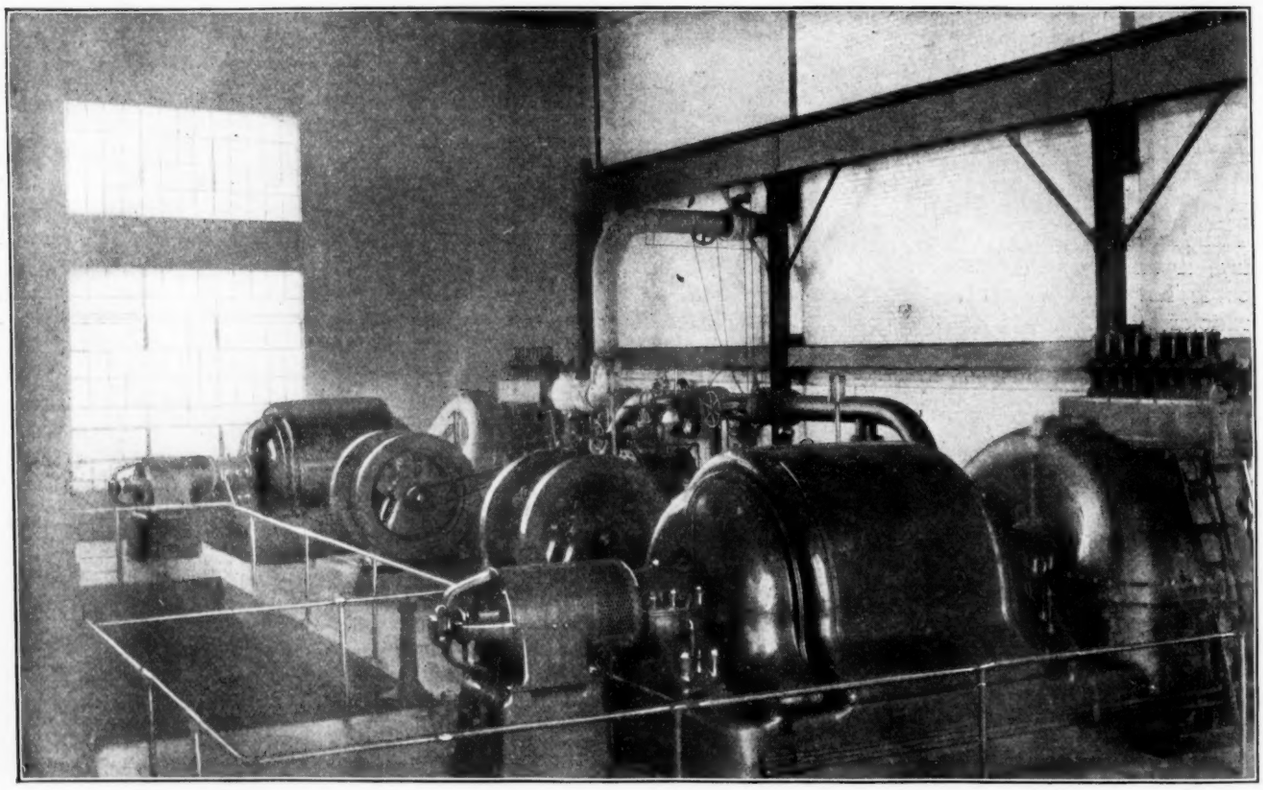


FIG. 1. TURBINE ROOM CONTAINING TWO 4000-KW. UNITS

Both air pumps serving the two condensers are on the main floor between the two turbines. They are of the same size, each having 10 and 22 x 18-in. cylinders.

These, together with the two 9 and 12 x 10-in. hotwell pumps, are steam-driven. The two duplex boiler-feed pumps are located between the two batteries of boilers. The general plan arrangement of the present equipment, with which is combined the portion now being built and a proposed future addition, is shown in Fig. 6. A 9 and 8½ x 10-in. fire pump is in the basement, also a 6 and 5¾ x 6-in. service pump. In case of emergency the fire pump can be used as a service pump.

FIG. 2. POWER PLANT FROM INTAKE END

In the boiler room there are four water-tube boilers, Fig. 4, each containing 4940 sq.ft. of heating surface. This allows 2.47 sq.ft. per turbine kilowatt, normal rating, if all boilers should be operated at once. One boiler, however, has been held as a reserve unit, making a ratio of 1.85 heating surface per kilowatt output. These boilers are equipped with mechanical stokers capable of operating the boilers continuously at 50 per cent. in excess of rating and 100 per cent. in excess of rating for a period of two hours with 0.05 in. draft over the fires. The combined efficiency of the boilers and stokers is 72 per cent.

Six additional boilers are to go in, four being on the ground ready for erection. The boiler furnaces now in service are fitted with curved arches, but the furnaces of the new units will have flat arches, which will undoubtedly remain in place for a longer period with hard firing.

One chimney takes care of the products of combustion from the four boilers. It is 205 ft. high above the ground level and for a distance of 70 ft. is lined with firebrick. The chimney that has been built for the new section of the plant is of the same size and construction. The chimney draft is 0.01⅛ in. of water and 0.023 to 0.045 in. over the fires.

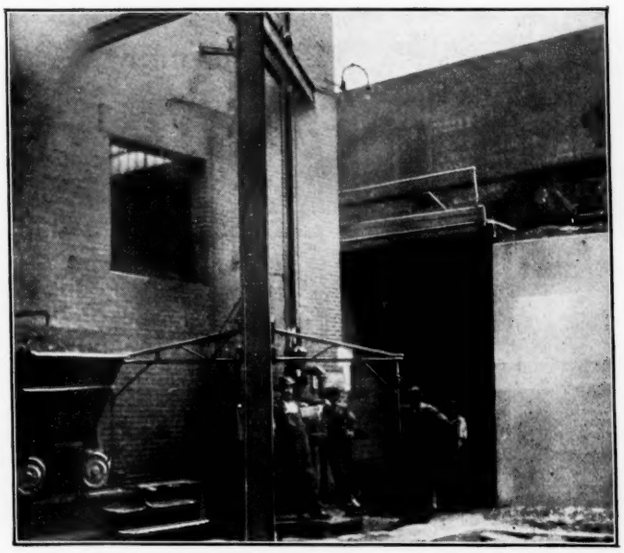


FIG. 3. PRESENT METHOD OF ELEVATING COAL TO THE STOKERS

This plant operates with an average coal consumption of 2½ to 3 lb. per kilowatt-hour and obtains an evaporation of 10.8 lb. per pound of coal containing 14,500 B.t.u. Continuous readings are taken of the flue gases with an average of 12½ per cent. CO_2. Separate indicating dials are placed in the boiler room, and the recording dial is in the turbine room. The load on the plant is exceedingly variable, and at times the boilers are brought up from a banked fire and are cut in on the line within a period of 20 minutes, their loads running as high as 250 per cent. of rating. Island Creek coal, nut and slack grades, is burned at present.

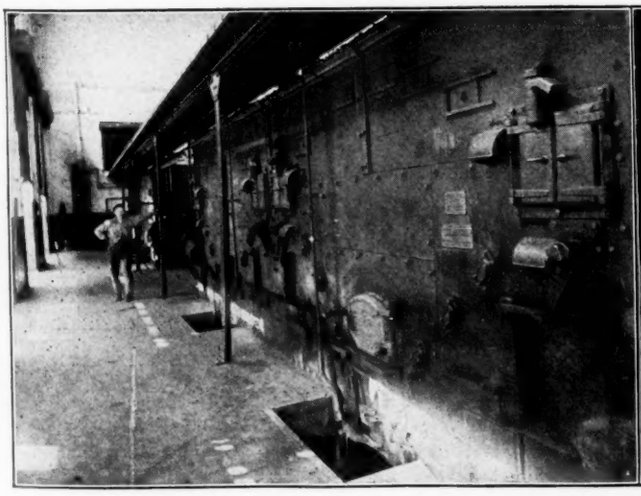


FIG. 4. OPERATORS' FLOOR IN FRONT OF STOKERS

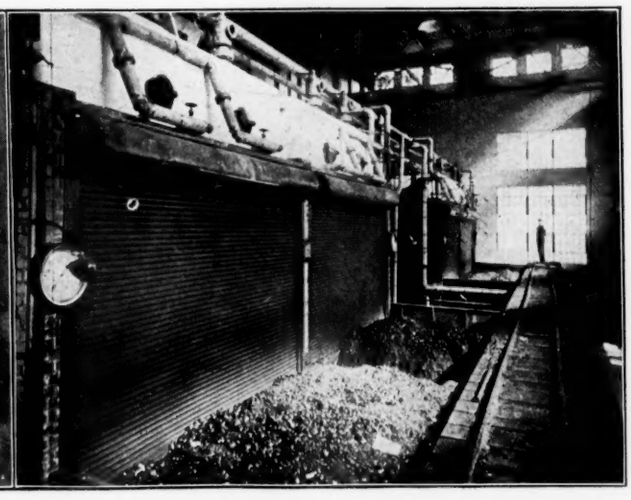


FIG. 5. COAL DELIVERY TRACK ABOVE STOKERS

A few months ago the station load was carried with varying boiler conditions to ascertain just what the plant would do. On Monday two boilers were used, and on Tuesday an additional boiler was cut in during the period of the day load from 7:30 a.m. to 5:30 p.m., but on Wednesday the load for the 24 hours was carried by one boiler. The results were as follows:

Day	Peak	Kw. in Output per 24 Hours	Coal per Kw.-Hr.
Monday	1,500	20,700	3.12 two boilers
Tuesday	1,650	20,700	2.86 half-and-half
Wednesday	1,800	21,000	2.63 one boiler

of these mines has been taken care of by one 500-hp. boiler, or a ratio of 1 to 8.2.

Since the foregoing figures were obtained, the load has so increased that peaks during November, 1917, ran as high as 6000 kw. with 6500 kw. swings, and the daily output has reached a maximum of 77,190 kw.-hr. This increase of load has necessitated the use of all four 500-hp. boilers.

Following is a typical set of readings taken shortly after the plant was started up with a load of about 1500 kw.-hr. output, at which the boiler steam-flow me-

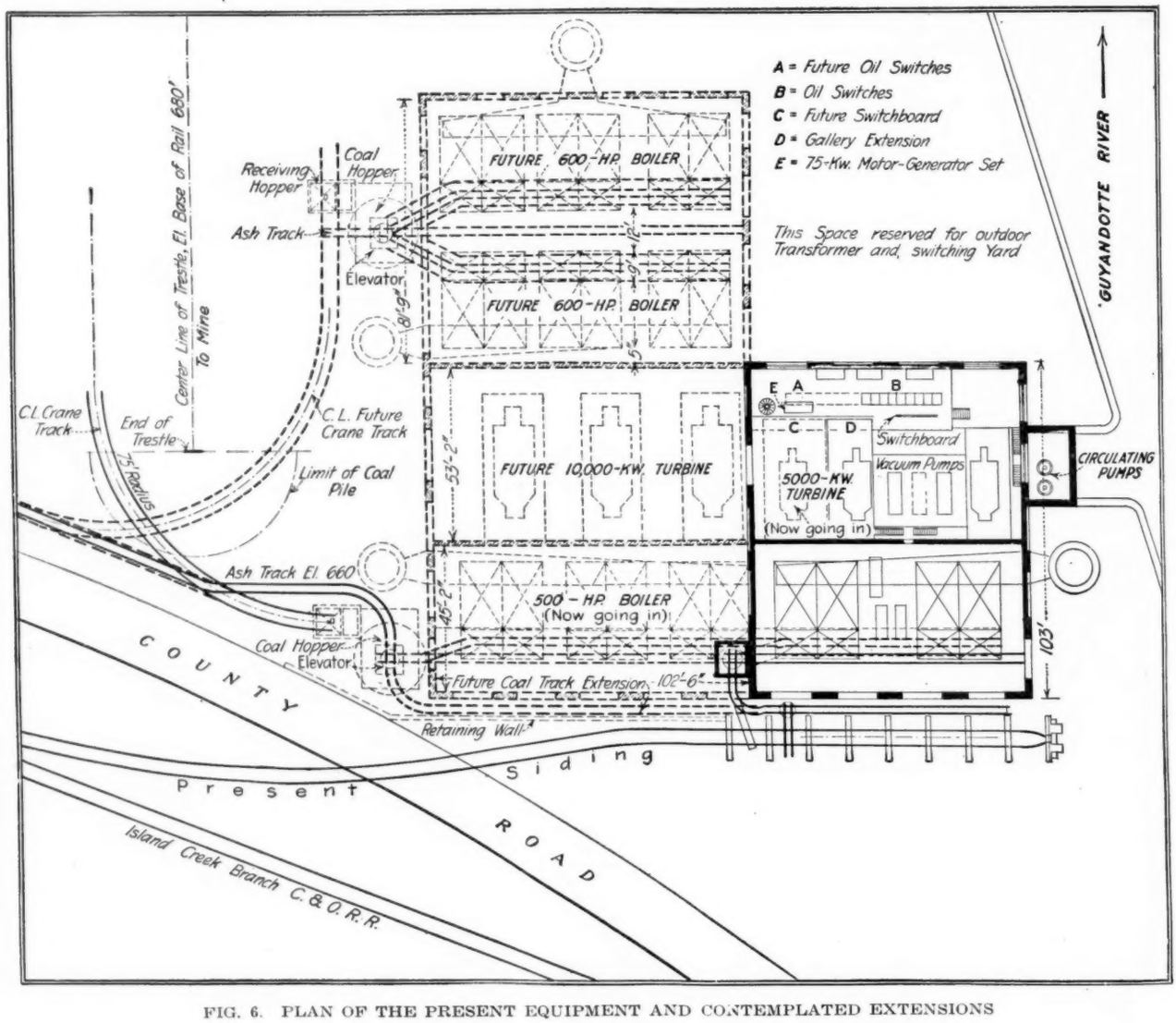


FIG. 6. PLAN OF THE PRESENT EQUIPMENT AND CONTEMPLATED EXTENSIONS

The largest output, 21,000 kw.-hr. for 24 hours, was carried by one boiler; the average load during the day was about 1500 kw.-hr., the remaining 6000 being the night load. An occasional peak during the day carried the load at times to 1800 kw.-hr. This gives an output of 3 kw.-hr. per boiler horsepower on the average load during the day and 3.6 kw.-hr. per boiler horsepower during the highest peak. The boiler has a nominal rating of 500 horsepower.

As already stated, this plant has taken over the load of a number of coal mines the total boiler capacity of which is 4100, or an average of 272.7 hp. per mine. As shown in the foregoing, the combined boiler capacity

ter showed an average indication of about 25,000 lb. per hour:

Load, kw	1,400
Boiler steam flow, lb	23,800
Turbine steam flow, lb	19,300
Auxiliaries (dif.) lb. steam	4,500
Steam pressure, lb	195
Steam temperature, deg. F	500
Steam temperature exhaust, deg. F	78
Water temperature, hotwell, deg. F	50
Water temperature, boiler feed, deg. F	112
Water temperature, intake condenser, deg. F	40
Water temperature, outlet, deg. F	49
Barometer atmosphere (mer. col.)	29.66
Vacuum on turbine, in	28.9
Power factor, per cent	99
Flow cooling water, gal. per min	4,200
Stack temperature flue gases, deg. F*	270
CO_2, per cent	9 to 10

* The stack temperature would indicate that the thermometer is either out of order or is placed in an unfavorable position.

Fuel for the plant is received at present by rail and is dumped into a steel bunker placed along one side of the boiler-house wall, as shown in Fig. 3. From this bunker the fuel is loaded into a side-dump car through a bottom outlet in the bunker. The loaded car is then pushed upon a revolving-top hydraulic elevator and lifted to the level of the charging track, which is in front of and above the top of the coal space over the dutch-oven furnaces. Arriving at this level, the car is turned one-quarter way around and pushed to whatever stoker requires coal, where the fuel is dumped, Fig. 5. supply of the same grade of coal excepting such slight difference in quality as may occur as the coal is mined. This coal will come in the mine cars from a local mine tipple direct to the plant. At the plant end of the line the track is carried by a trestle from which the coal can be dumped into a storage pile. From the storage pile a locomotive crane will take the fuel to the coal hopper of a 1½-ton skip-bucket hoist, which will elevate it to the top and discharge it into a hopper containing a bar screen with 3-in. spacing. This screen is placed at an angle of 40 deg., and all coal passing through it

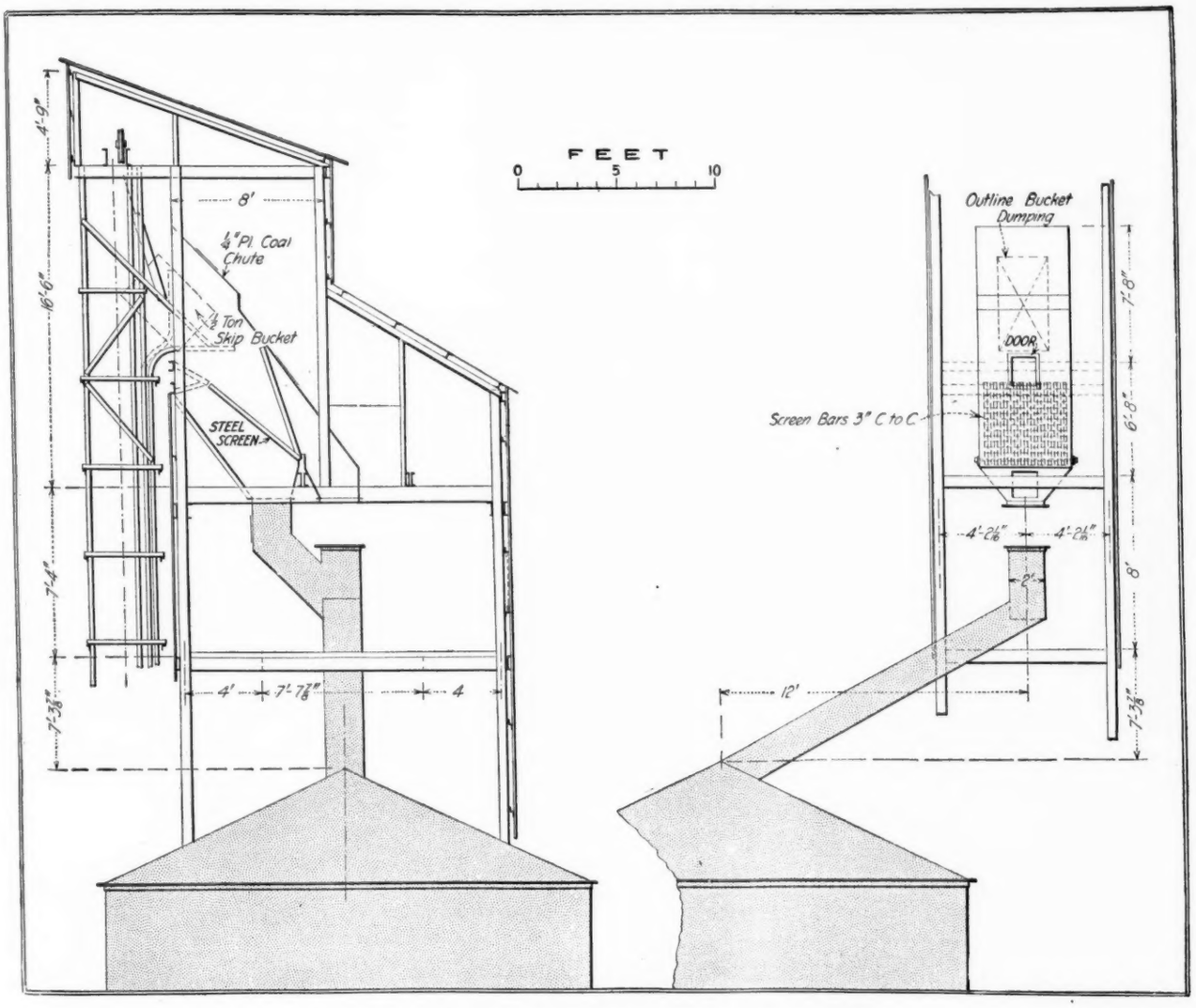


FIG. 7. OUTLINE OF PROPOSED SKIP BUCKET HOIST

When the six new 500-hp. boilers are installed in the addition that is now being constructed, the wall between the old and the new boiler rooms will be removed, making one boiler room, containing 10 boilers, 190 ft. long.

The coal supply to any power plant is sometimes a vexatious problem, especially when the delivery is from a distance. Furthermore, with coal bought in the market no two carloads are likely to be of the same quality, and as a consequence there is a constant changing in the method employed in burning it.

When the new boiler units are put in operation, all coal will be from one mine, which will insure a constant goes to a bin of 150 tons capacity. All coal that does not pass through the screen goes into a second chute, which discharges into a set of crushing rolls, after which it passes through a 2-ft.-square chute to the bin, whence it is discharged into an industrial side-dump car and pushed over a track into the boiler house and dumped into the hopper over the stokers. Fig. 7 gives an outline elevation of the skip hoist. The coal bin now used will be retained for emergency use in case an accident should happen to the skip hoist.

Ashes are now handled by dumping them into an ash car, shown at the left in Fig. 3, and are used for filling in The loading is done in the basement, and the car is

hoisted by the same elevator that handles the coal. A new electric ash hoist will be put in with the new boiler, and it will handle the coal from the old bin in case it is necessary to do so.

That it is the aim to operate the plant efficiently is indicated by the very complete apparatus with which it is equipped. Besides the CO_2 machine and flow meter, there are feed-water regulators for the boilers, soot blowers for blowing the boiler tubes, a V-notch metering heater and recording temperature gages.

In order to know just what the plant performance is, a set of records is kept. The daily log, Fig. 8, is arranged for plotting the load curve up to 9500 kw. capacity. Below this is the record for the turbines and boilers, and the opposite portion of the log is devoted to meter records—coal, water and miscellaneous. From this daily sheet the monthly log, is compiled, thus giving the totals of kilowatt-hours, water evaporated, coal burned, etc. At the bottom space is provided for a record of new customers, new meter connections, etc. As a convenience in tests, a boiler-test sheet is provided.

The load conditions are rather favorable in this plant, inasmuch as the heavy motor day load begins to drop before the evening lighting load comes on, which averages about 6000 kw.-hr. and is carried by one boiler and one turbine.

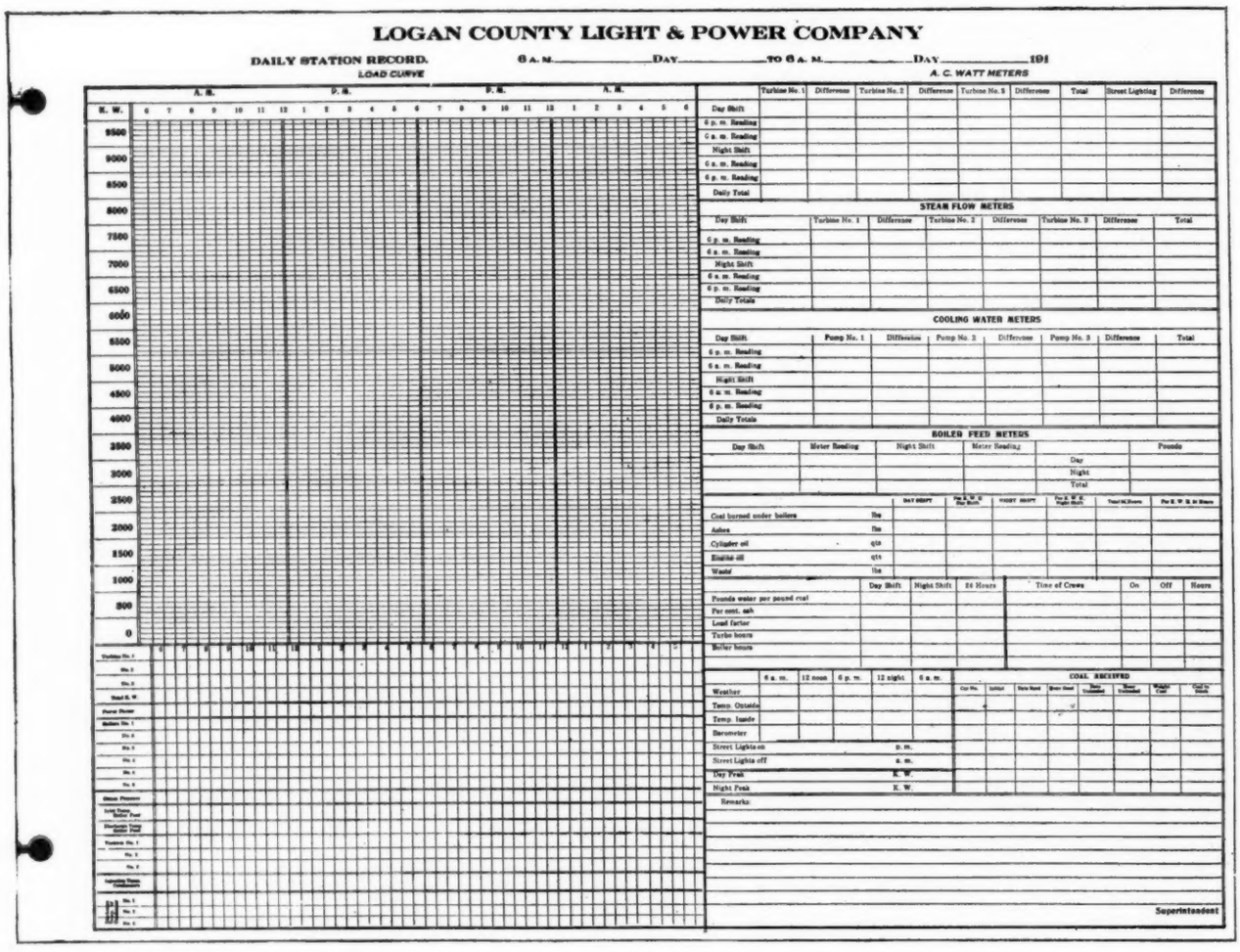


FIG. 8. DAILY LOG SHEET

PRINCIPAL EQUIPMENT OF THE LOGAN COUNTY LIGHT & POWER CO.

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
2	Turbines	Horizontal	4,000-kw.	Main generators	3,600 r.p.m., 195 steam pressure, 115 deg. sup., 2,300 volts, 3-phase, 60-cycle	General Electric Co.
2	Condensers	Surface	9,000-sq.ft.	With main turbines	8,000 gal. water per min	Henry R. Worthington
2	Pumps	Circulating	8,000-gal.	With condensers	8,000 gal. capacity per min	Henry R. Worthington
2	Motors	Induction	75 h.p.	Driving circ. pumps	550 volts, 3-phase, 60-cycle	General Electric Co.
2	Pumps	Horizontal air	10 x 22 x 18 in.	With condensers	Reciprocating	Henry R. Worthington
2	Pumps	Duplex	9 x 12 x 10 in.	Hotwell	Steam-driven	Henry R. Worthington
2	Pumps	Duplex	12 x 7 x 12 in.	Boiler feed	Steam-driven	Henry R. Worthington
1	Pump	Duplex	9 x 8½ x 10 in.	Fire and service	Steam-driven	Henry R. Worthington
1	Pump	Duplex	6 x 5⅜ x 6 in.	Service	Steam-driven	Henry R. Worthington
4	Boilers	Water-tube	4,940 sq.ft.	Main steam generators	195 lb. pressure, 115 deg. superheat	Edge Moor Iron Co.
4	Stokers	Detroit		With boilers	Engine-driven	Detroit Stoker Co.
1	Chimney	Concrete	205 ft. high	Serves four 500-hp. boilers	Natural draft	General Concrete Construction Co.
5	Meters	Steam-flow		Steam lines on boilers	Automatic	General Electric Co.
4	Regulators	Copes		Boiler feed-water regulation	Automatic	Erie Pump & Equipment Co.
4	Blowers	Diamond		Blowing boiler tubes	Intermittent	Diamond Power Specialty Co.
1	Heater	V-Notch		Metering and heating feed water	With exhaust steam	Harrison Safety Boiler Works
1	Recorder	CO_2	4-unit	Flue gases	Continuous	Uehling Instrument Co.
1	Crane	Traveling	20-ton	In turbine room	Electrically operated	Northern Engineering Works
1	Filter	American		Purifying feed water	When water is muddy	American Water Softener Co.

Consulting Engineer, F. R. Weller, Washington, D. C.

Oil-Engine Exhaust Heating

Exhaust gases from an oil engine are passed through an economizer to heat the jacketing water for heating a factory building. In case of light engine load live steam from a small auxiliary boiler raises the water to the desired temperature while passing through an auxiliary heater. The admission of steam is automatically controlled.

ENGINEERS long ago realized the value of utilizing exhaust steam from steam engines for heating boiler-feed water. As a result various types of heaters have been designed with a view of obtaining the greatest heat transfer possible from the exhaust steam to the water.

In line with this conservation of heat it has been realized that an additional saving in waste-heat units

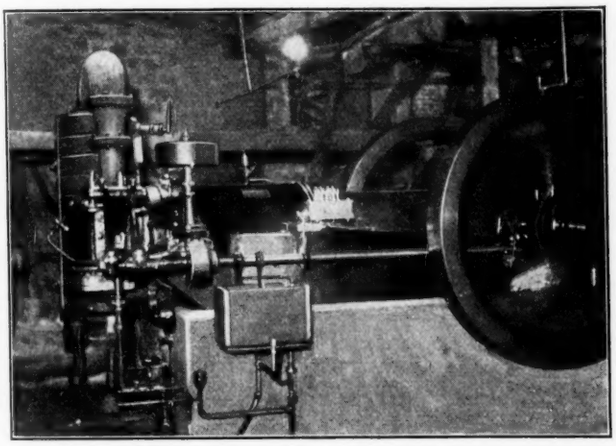


FIG. 1. ECONOMIZER CONNECTION AT THE CYLINDER END OF THE ENGINE

could be made by passing the feed water through an economizer and heating it, by means of the escaping furnace gases, to a higher temperature than could be obtained by exhaust-steam heating. Both of these methods have become standard practice in power-plant operation.

With the introduction of the gas and oil engine a problem developed that called for a different solution from that presented by exhaust-steam heating. In using exhaust steam there is but little trouble experienced in the deterioration of the metal of which the heater is constructed, but in using the exhaust gases from a gas engine there is trouble because the gases attack the metal.

In most cases it is just as desirable to use the heat units in the exhaust gases for heating water as it is to use exhaust steam for the same purpose. This hot water so heated is generally sufficient to heat the building for which the gas engine supplies power.

An installation where such an arrangement is being successfully used is at the plant of the American Chocolate Almond Co., of Jersey City, N. J. The power plant consists of a 60-hp. oil engine, Fig. 1, running at 225 r.p.m. and belt-connected to the factory shafting. The exhaust gases from this engine are used to heat the water employed in heating the factory by passing them through a vertical gas-engine economizer, Fig. 2. This is constructed of cast iron and made of ten round sections so arranged that the exhaust passages of each section are staggered. This brings the hot exhaust gases into contact with the entire heating surface from the point of inlet to the outlet. The water space surrounds the walls of the gas passages, and the gases and water flow in opposite directions, or counter-current.

In this particular instance the 6-in. exhaust pipe from the engine is increased to 10 in. diameter by means of a tapered flanged thimble, as shown in Fig. 1. The end of the 10-in. pipe connects to the top of the economizer. This increase in the size of the inlet exhaust pipe and other connections necessary in bringing about the best results in economy of this installation, were especially designed and installed by P. D. Panoulias, proprietor and general manager of the factory, the purpose being to reduce the friction of the gases in passing through the pipe. At the bottom a 6-in. exhaust pipe runs to the atmosphere.

Jacket water from the engine is used to heat the factory. It enters the economizer at the bottom and is discharged at the top into an overflow chamber, as shown in Fig. 2. The usual method of breaking the

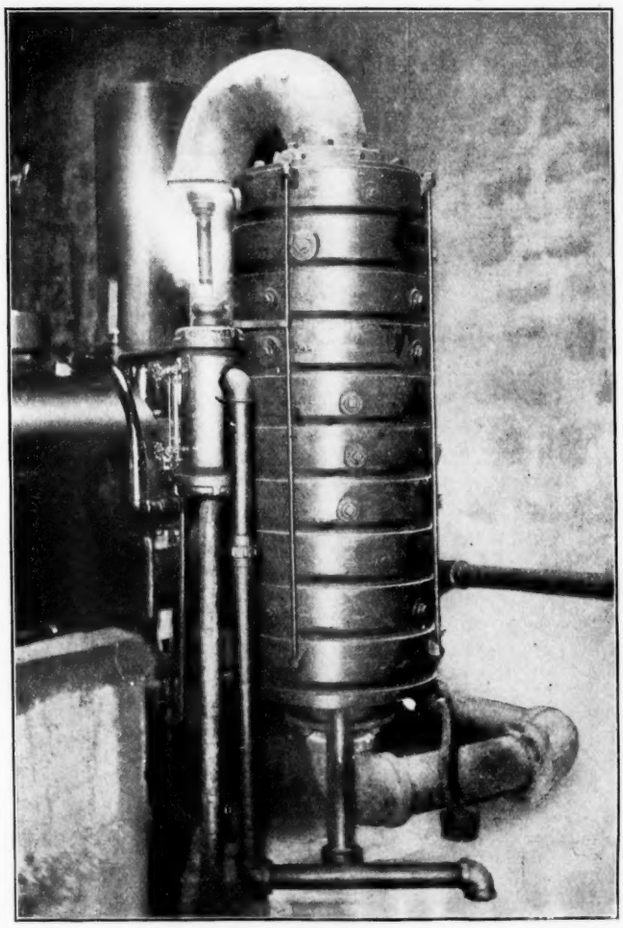


FIG. 2. GAS-ENGINE ECONOMIZER AND CONNECTIONS

connection of the jacket discharge so as to know that the flow of water is constant is employed. The jacket water enters the heater through a 1¼-in. pipe at a temperature of between 150 and 160 deg. F. The discharge temperature is about 190 to 210 deg. F. according to the load on the engine.

The overflow tank is fitted with a gage-glass and with an overflow pipe that connects near the top. At the bottom of the overflow chamber a 2-in. pipe is run to a belt-driven triple-plunger pump. If water is not used for heating purposes, it goes to a storage basin outside the plant through the overflow pipe. During the heating season the belt-driven pump forces the water through the factory coils, from which it is returned to the storage basin.

Sometimes the engine is underloaded, in which case the water is not brought up to a temperature sufficient to properly heat the building. In such an event provision has been made to supply the necessary additional heat by forcing the water through a horizontal live-steam heater, located in the boiler room, where a small upright boiler is installed, carrying about 10 to 15 lb. pressure. The temperature of the water governs the admission of steam from the boiler, which is automatically controlled by a thermostatic valve. When the water has been heated to the desired temperature, the valve cuts off the steam supply.

Condensate from the heater is piped to a receiving tank from which it can be pumped either to the heating system with the regular jacket water, or to a set of cooling coils on the roof and returned to the storage basin for use in the engine jacket.

The water-storage basin is in solid rock and is of such character that the only wastage is from evaporation. Water for jacketing purposes is taken from this basin and, after passing through the building heating coils, is returned; the amount of makeup water is therefore very small.

Pitting of Steel Piping

One of the perplexing problems with which engineers have to deal is the pitting of steel pipes, now so commonly used in steam and water lines, and the pitting of superheater tubes. Some trouble is also experienced with the pitting and rupturing of steel boiler tubes. In the instance of tubes used with fire- and water-tube boilers most cases of rupture, particularly in water-tube boilers, are probably caused by overheating, although some of the failures are due to structural defects in the tubing.

Hot-water lines are particularly subject to pitting, a peculiarity being that in most cases the metal surrounding the hole in the pipe remains at its original thickness and the metal where the hole penetrates through the outside skin appears as if some foreign material had found its way into the metal during the process of manufacture. Fig. 1 shows such a pit, and in this instance it occurred at the joint of the weld, starting from the inside of the pipe.

In Fig. 2 is shown a section of 1½-in. seamless-drawn mild-steel tubing. The hole came in the tube just at the outside edge of the header box, the worn area evidently having been caused by blowing steam from the pinhole that probably formed at first.

Here are two instances of steel pipe and tubing pitting under entirely different usage and both occurring in the same plant. One was exposed to hot water and the other to steam and heat from the furnace, yet each failed owing to pitting.

What is the reason?

Steam-Carrying Capacity of Pipes

By W. H. Thies

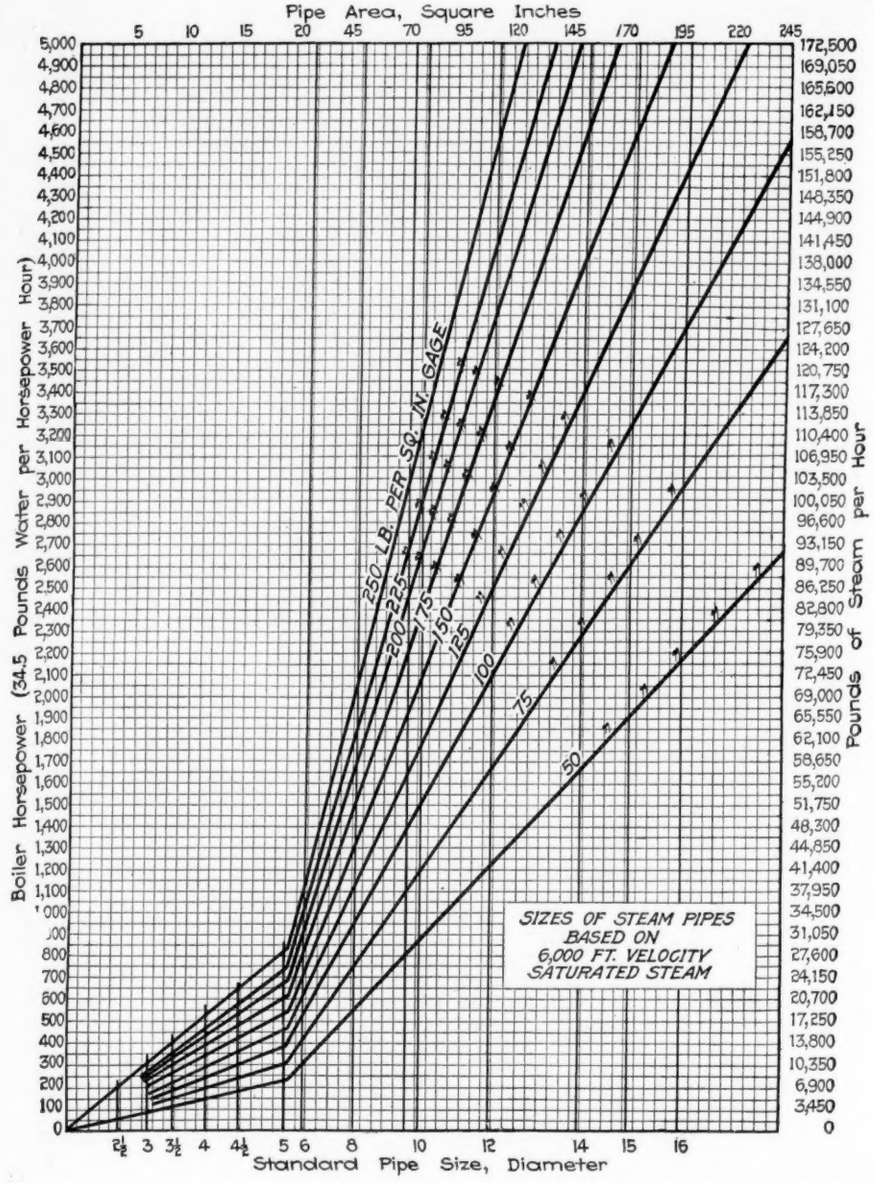
The four charts on the following pages are designed to give, at one reading, the pounds of steam or the rated horsepower that a pipe of a given size will supply under the conditions of pressure, heat and velocity given. The two velocities and temperature conditions used offer sufficient range from which to determine the pipe size for almost any other condition as near as the commercial pipe sizes will permit.

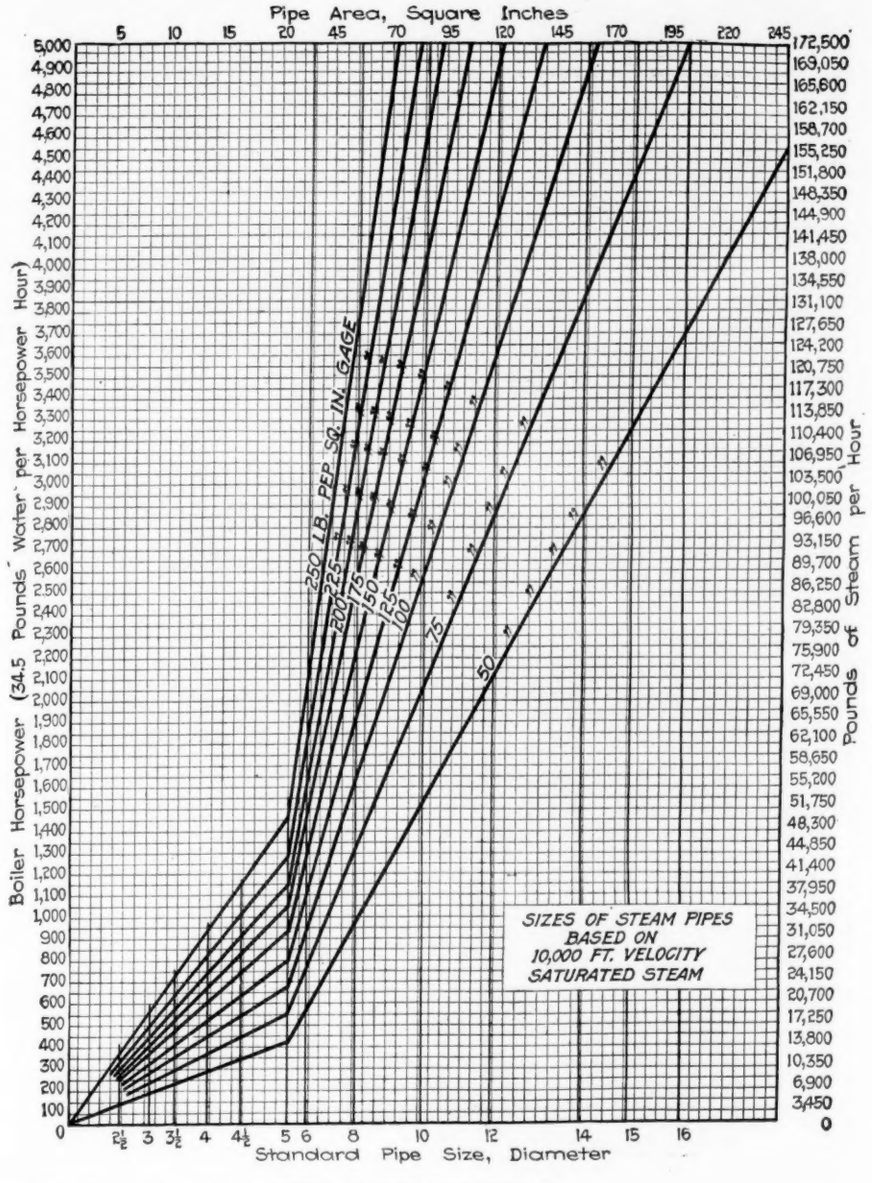
It is well to remember that pipe sizes are only nominal at best and that 14-in. and over is "outside diameter."

The charts have been found extremely useful. They are entirely original and have never before been published.

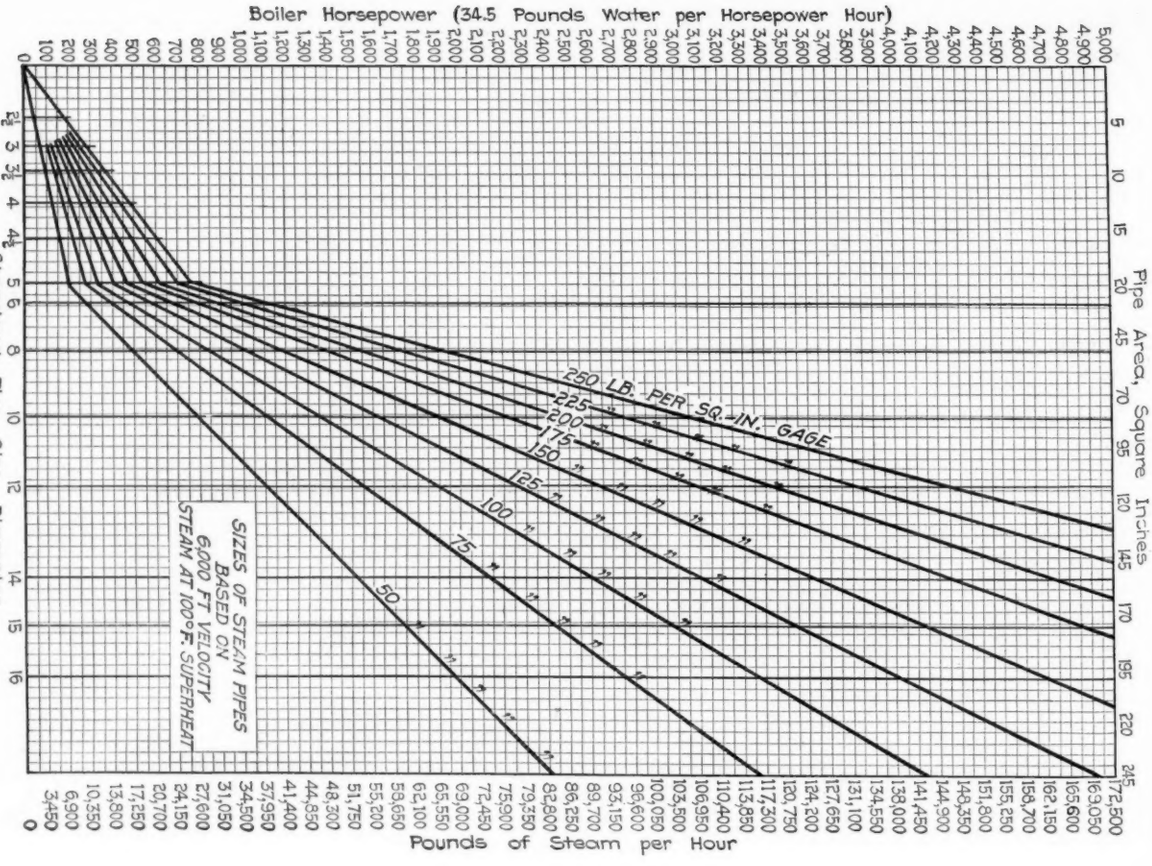
FIG. 1. PITTED STEEL PIPE

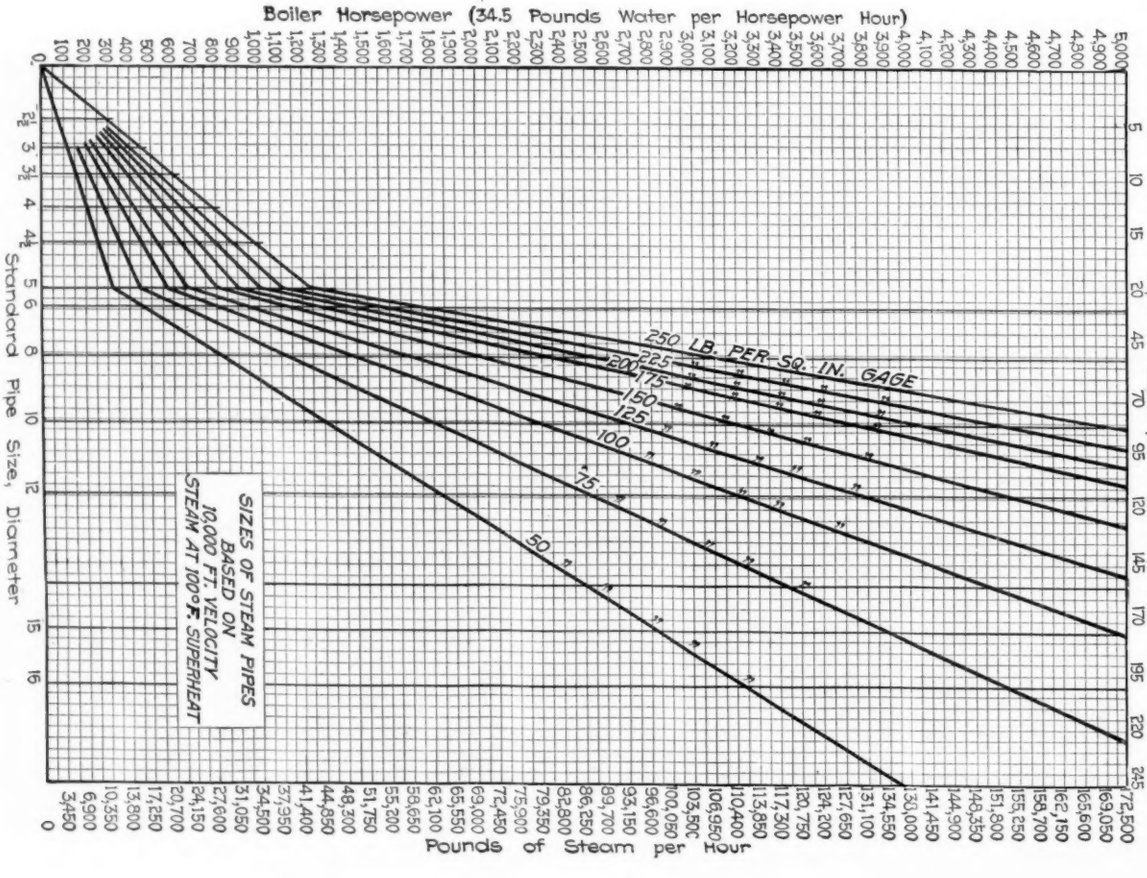
FIG. 2. PITTED STEEL SUPERHEATER TUBE


Pipe Area, Square Inches
5 10 15 20 45 70 95 120 145 170 195 220 245
Boiler Horsepower (34.5 Pounds Water per Horsepower Hour)
Pounds of Steam per Hour
250 LB. PER SQ. IN. GAGE
225
200
175
150
125
100
75
50
SIZES OF STEAM PIPES BASED ON 6,000 FT. VELOCITY SATURATED STEAM
Standard Pipe Size, Diameter
2½ 3 3½ 4 4½ 5 6 8 10 12 14 15 16


Pipe Area, Square Inches
5 10 15 20 45 70 95 120 145 170 195 220 245
Boiler Horsepower (34.5 Pounds Water per Horsepower Hour)
Pounds of Steam per Hour
250 LB. PER SQ. IN. GAGE
225
200
175
150
125
100
75
50
SIZES OF STEAM PIPES BASED ON 10,000 FT. VELOCITY SATURATED STEAM
Standard Pipe Size, Diameter
2½ 3 3½ 4 4½ 5 6 8 10 12 14 15 16

CHARTS SHOWING THE STEAM-CARRYING CAPACITY OF PIPES UNDER CONDITIONS GIVEN—SATURATED STEAM



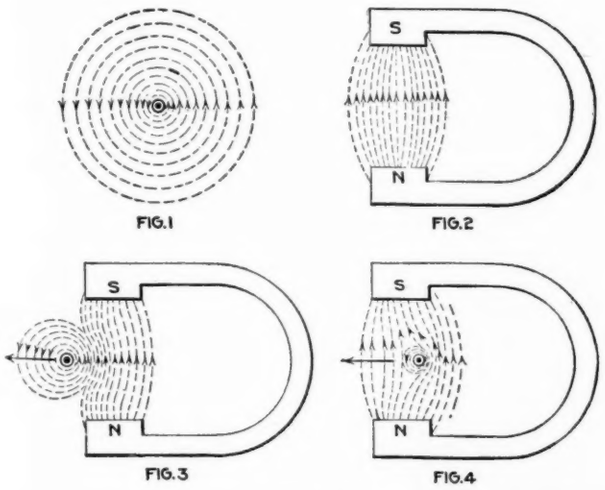


CHARTS SHOWING THE STEAM-CARRYING CAPACITY OF PIPES UNDER CONDITIONS GIVEN—SUPERHEATED STEAM

The Electrical Study Course—Fundamental Principle of the Electric Motor

It is shown that when an electric current passes through a conductor in a magnetic field, the conductor has a tendency to move at right angles to the lines of force.

BEFORE giving further consideration to the electric generator, it is necessary that the fundamental principle of the electric motor be understood. We have already seen that when an electric current flows through a conductor it sets up a magnetic field about the latter, as in Fig. 1, and that when a conductor moves across a magnetic field so as to cut the lines of force, an electromotive force is generated in the conductor, which will cause a current to flow if the ends of the conductor are connected together. This brings up the question of what effect a magnetic field has upon a conductor carrying a current when the latter is placed in the former. Fig. 2 shows a horseshoe magnet, the magnetic field of which will be, if not subjected to an influence, uniformly distributed as indicated. If a conductor through which a current is flowing is brought near the field of a magnet, as in Fig. 3, the result will be that shown in the figure. If the current is flowing up through the plane of the paper, the lines of force about the conductor adjacent to the field of the magnet are in the same direction as those of the latter. This being the case, the two fields are forced in together between the conductor and the magnet and cause a distortion of both as shown. Lines of



FIGS. 1 TO 4 ILLUSTRATE THE FUNDAMENTAL PRINCIPLE OF THE ELECTRIC MOTOR

magnetic force always act like elastic bands in tension; they may be distorted, but tend to take the shortest path, and that is just what is illustrated in Fig. 3. Under the conditions shown, the field of force of the magnet tends to push the field of the conductor and along with it the conductor to the left, as indicated by the arrow.

If the conductor is placed in the center of the magnetic field, as in Fig. 4, the result will be as given. The flux from the magnet and about the conductor are in the same direction on the right-hand side of the latter, but opposed on the left-hand side. Consequently, part of the flux from the magnet on the left-hand side of the conductor will be distorted to the right side, as shown, causing even a greater distortion of the field

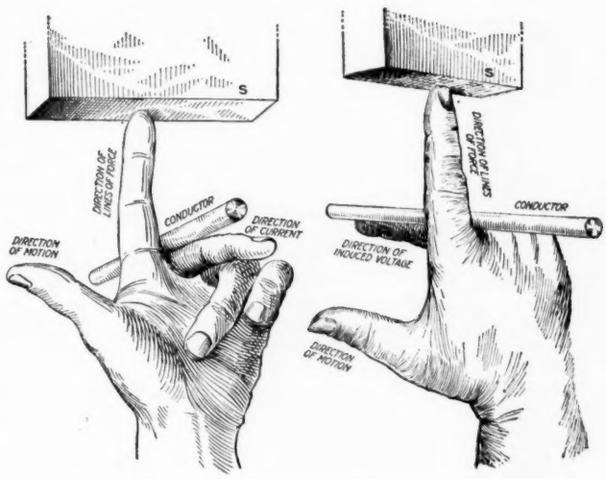


FIG. 5. LEFT-HAND RULE FOR MOTOR

FIG. 6. RIGHT-HAND RULE FOR GENERATOR

than in Fig. 3, and will also tend to cause the conductor to move to the left. What we have just seen is the fundamental principle of the electric motor and may be expressed thus: A conductor carrying a current in the field of a magnet tends to move to cut the lines of force of the latter at right angles. This, it will be seen, is the inverse of the fundamental principle of the electrical generator, which is, a conductor moved across a magnetic field so as to cut the lines of force has an electromotive force induced in it.

It is evident from what we have seen in Figs. 3 and 4 that the direction the conductor will tend to move in depends upon the direction of the current in the conductor and the lines of force of the magnetic field. The direction can be determined in the same way as for the direction of the electromotive force developed in a conductor, but using the left hand instead of the right. Placing the first three fingers of the left hand at right angles to each other, as in Fig. 5, if the middle finger points in the direction of the current in the conductor and the forefinger in the direction of the lines of force, then the thumb will always point in the direction that the conductor will tend to move in. Hence, if either the direction of the current or the lines of force are reversed, the direction of motion of the conductor will be reversed. This is true in all cases, when the rotational direction of a direct-current motor's armature is reversed; the direction of the current is reversed through the armature conductors or through the field coils, the latter changing the direction of the magnetism of the field poles, as will be seen in later lessons.

.In Fig. 4 we have seen that with the lines of force and current in the direction indicated, the conductor will tend to move to the left. As soon as the conductor begins to move, it will be cutting the field of the magnet. Consequently, an electromotive force will be generated in the former. By applying the rule, Fig. 6, for the direction of the electromotive force in the conductor, it will be seen that the generated electromotive force is opposite to the direction of the current; that is, the voltage developed in the conductor is opposite to the pressure that causes the current to flow in the conductor. This back pressure, as it may be termed, is called a counter-electromotive force and, as will be seen later, is an important factor in the operation of the electric motor. What has been shown in this and the preceding lessons indicates that whenever a conductor moves in a magnetic field or a magnetic field is moved across a conductor so that lines of force are cut, no matter what the conditions may be, there will always be a voltage induced in the conductor. From this very fact many of the most serious problems in the operation of electrical machinery and circuits arise.

In Fig. 7, if the conductor is moved upward, as indicated, a voltage will be induced in it that will cause a current to flow in the direction indicated. However, from what we have learned in the foregoing, when the current flows in the conductor it will tend to cause the conductor to move in a direction to cut the lines of force or, in other words, produce the condition of an electric motor. This is just what would happen in Fig. 7. Mechanical force is applied to cause the conductor to move upward, which causes the current to flow in the circuit. The magnetic field set up by the current in turn reacts upon the flux from the magnet

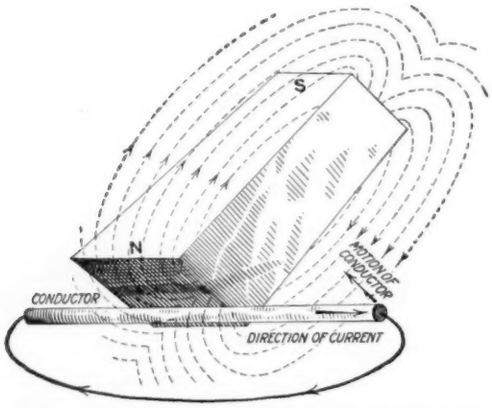


FIG. 7. CONDUCTOR IN A MAGNETIC FIELD

and also tends to impart motion to the conductor. By applying the rule for the direction of motion of the conductor, due to the current it is seen that it tends to move downward, or opposite to the direction the mechanical force is causing it to move in. This point brings out the way that an electric generator is loaded. The source of driving power turns the armature in a given direction, which produces a voltage and causes a current to flow; the current flowing through the armature conductors in turn produces a reverse, or counter-turning, effort to that produced by the steam engine or other source of motive power driving the generator. However, the counter-turning effort caused by the action of the current on the magnetism from the poles cannot be so great as the applied power, or the machine would stop. But the greater the number of amperes supplied by the armature for a given voltage, the greater the counter-turning effort. Consequently, the source of motive power will have to develop a greater effort to overcome that produced by the current. The same way with a motor, the counter-electromotive force cannot be so great as the applied voltage, or no current would flow through the conductors on the armature and the machine would stop. The foregoing shows that the electric motor and the generator are very closely interrelated. In fact, the fundamental principle of one is always embodied in the other. The machine that can be used for a motor can also be used for a generator, the only difference in their design being slight modifications to obtain certain desired characteristics. This interrelation of the motor and generator will be treated in future lessons.

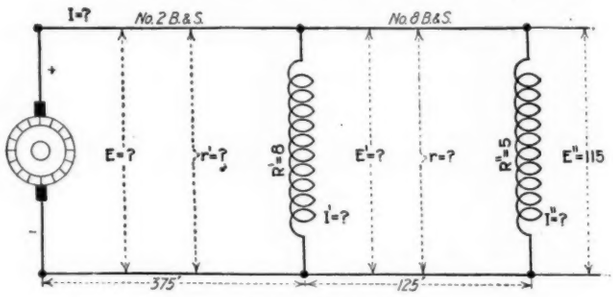


FIG. 8. COMPLEX CIRCUIT

Fig. 8 shows the layout of the problem given in the last lesson. $I'' = \frac{E''}{R''} = \frac{115}{5} = 23$ amperes. The resistance r of the two conductors between R' and R'' is equal to the resistance of 250 ft. of No. 8 conductor. Then $r = \frac{10.7L}{cir.mils} = \frac{10.7 \times 250}{16{,}510} = 0.162$ ohm. For 23 amperes to flow through the resistance of the two conductors will require a voltage $e = rI'' = 0.162 \times 23 = 3.73$. Therefore $E' = E'' + e = 115 + 3.73 = 118.73$ volts, and $I' = \frac{E'}{R'} = \frac{118.73}{8} = 14.84$ amperes. Current supplied to the circuit is $I = I' + I'' = 14.84 + 23 = 37.84$ amperes. Resistance of the two conductors from R' to the armature is that of 750 ft. and No. 2 wire. Then $r' = \frac{10.7L}{cir.mils} = \frac{10.7 \times 750}{66{,}370} = 0.12$ ohm. Now 33.84 amperes flowing through the resistance of these two conductors will require a voltage $e' = Ir' = 37.84 \times 0.12 = 4.54$ volts, and the total volts $E = E' + e' = 118.73 + 4.54 = 123.27$. The joint resistance of the circuit is $R = \frac{E}{I} = \frac{123.27}{37.84} = 3.26$ ohms.

A given circuit supplies two loads, one of 150 amperes 350 ft. from the power source, and a second load of 125 amperes 425 ft. from the first, farther out on the line. If the voltage at the source is 240, what will it be at each load if the conductors are rubber covered and selected according to the size given in the wire table; find the voltage at each load, the watts supplied to each load, the watts loss in the line and the total watts supplied to the system.

War's Influence on the Coal Situation

By CHARLES H. BROMLEY*

An analysis of the coal situation, particularly as related to its use for the production of steam and power in the industries. The rail and marine freight conditions as they have been and are likely to be. "Power's" clientele, that is, producers of steam and power, use at least 42 per cent. of the coal mined. Increased consumption by the railroads and the industries. How the fuel situation is handled by other countries. Government control of mines and railroads far greater in scope than heretofore practiced or publicly announced, is necessary to solve the increasing difficulties.

FUNDAMENTALLY and primarily the coal shortage is not due to decreased production at the mines, nor to car shortage, nor freight embargoes, nor unprecedented consumption. America is short of coal because it did not realize soon enough the awful gravity of the war as it concerned it, even in the days when it was neutral—in short because America was not, aye, is not yet, governed by a dictatorship commensurably absolute with the internationally disturbed conditions. But we are in the mess now; the job is to get out of it—quickly. Conditions have reached such an acute stage that the situation bids fair to straighten out its many serious kinks, the chief of which is now transportation of the coal to the places of consumption.

Let us get a proper perspective of the situation before going into details. The curve, Fig. 2, shows the coal production of the United States from 1900 to 1916. Fuel Administrator Garfield is reported as saying that the production will be between 640 and 650 million tons for 1917, and that this will be 7½ per cent. below requirements. Then there will be a shortage of 48,750,000 tons. Keep this figure in mind. The coal year begins Apr. 1 of each year.

The most authoritative figures for consumption give:

	Per Cent.	Tons *
Steam, power and industrial	60	360,000,000
Railroads	20	120,000,000
Domestic	20	120,000,000

* Based on production taken as 600,000,000 tons for 1916.

The chief items in the estimated increase in demand are:

Consumer	Increase in Demand Over 1916, Tons	Usual Normal Consumption Per Annum, Tons	Percentage Increase Over Normal Yearly Consumption, Tons
Railroads *	40,000,000	125,000,000	32
Steel industries *	40,000,000	.....	...
Cotton (New England and Carolinas) *	40,000,000	.....	...
Steam and power †	63,000,000	252,000,000	25

* Federal Trade Commission.

† Estimate by the author. This is likely lower than there actually will be owing to the poorer quality of coal being furnished. An increase of 20 per cent. in coal consumption per unit of output (power) is reported from many quarters. Some balance will of course be struck, for with pooled coal some consumers will get a better grade than they usually received previous to pooling. Therefore it would be misleading to assume that 20 per cent. of the total consumption, or 252,000,000 × 0.20 = 50,400,000 tons, will be the approximate increase owing to the use of coal of poorer than usual quality.

The Fuel Administrator's estimate of 7½ per cent. shortage in production for 1917, based on 650,000,000 tons production for the year, is, it seems certain, much too low. The estimated increase in consumption is:

Industry	Tons Increase Consumption for the Year
Steam and power other than steel and cotton mills	63,000,000
Steel	40,000,000
Railroads	40,000,000
Cotton	4,000,000
* Total	147,000,000

* How much more coal the United States Navy is using than during peace periods the author, at this time, has no figures; but it obviously is very much more.

The percentage short of requirements, therefore, would seem to be more nearly $\frac{147,000,000}{650,000,000} \times 1.00 =$ 22.6 per cent. instead of 7½ per cent. The production for the year (1917) should therefore be over 725,000,000 tons. This estimate is corroborated by the Federal

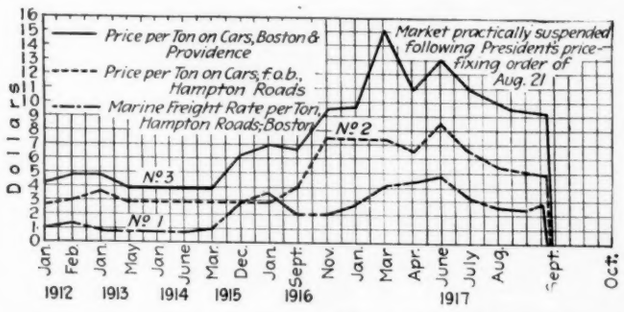

Price per Ton on Cars, Boston & Providence
Price per Ton on Cars, f.o.b., Hampton Roads
Marine Freight Rate per Ton, Hampton Roads-Boston
Market practically suspended following Presidents price-fixing order of Aug. 21
No 2
No 3
No 1
Dollars
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Jan Feb Jan May Jan June Mar Dec. Jan Sept. Nov. Jan Mar Apr. June July Aug. Sept. Oct.
1912 1913 1914 1915 1916 1917

FIG. 1. BEHAVIOR OF COAL PRICES AND FREIGHT RATE FOR NEW ENGLAND

Trade Commission's report of June 20, 1917, page 84: "The normal demand for coal of all kinds showed a larger increase in 1916 than in any one year for the last twenty. It has been estimated by the trade authorities that the increased demand for all coal was fully 20 per cent." Certainly, one conversant with the demand conditions has no doubt but that demands for the year ending Mar. 31, 1918, will be greater than for 1916. Canada increased her coal consumption 25 per cent. last year. Table I gives the various causes for bituminous-coal output fluctuations.

Transportation—Coal production and rail and marine transportation are inseparable parts of one problem. Miners do not usually go into the mines unless cars are on the job to receive their output. Therefore any shortage of cars brings about two serious evils, especially at a time of high cost of living; namely, decrease in production of coal, and labor unrest owing to the men working but, say, four days per week, drawing pay for only four days, while the busy industries are crying for men and paying comparatively much higher wages than the miners receive. The great increase in volume of freight other than coal seriously disturbs the economical transportation balance. The Federal Trade Commission points out that maximum economy occurs when out of every 100 tons of originating freight approximately 56 tons are unmanufactured mineral products and 44 are manufactured products, foodstuffs and other commodities, and when of the 56 tons of mineral products 35 tons are coal.

*Associate editor, "Power."

The Geological Survey in its weekly report for Nov. 24, 1917, states that losses due to car shortage increased in the aggregate from 14.5 per cent. for the week ended Nov. 3 to 15.3 per cent. for the week of Nov. 10. The Federal Trade Commission reporting the alarming car shortage for Nov. 1 claimed a shortage of 140,000 cars, which is more than 25,000 cars in excess of that for the same date last year, with the situation rapidly growing worse.

No one seems to know just what to do to relieve the freight situation. The Government has lately appointed a committee composed of the vice presidents of the several Eastern roads, and they are to operate all these roads as one system to most expeditiously direct freight. Some good will, of course, come of this; but past experience here and abroad shows that the Government must take a firmer stand. The transportation situation needs a Hoover, a dictator, competent and unafraid and with no economic strings tying him to his job. If rolling stock is deteriorating and the railroads have no money for investment in new cars, let the Government determine this quickly, compel the ordering and building of an adequate number of cars and then arrive at an equitable apportionment of payment for the cars between itself and the railroads—and further, guarantee a profit equal or nearly equal to an average of that for the three years prior to 1914.

The marine-freight situation has improved a little since the Shipping Board took absolute control over all ships and shipping. Curve No. 1, Fig. 1, shows the behavior of marine-freight rates (independent[1]) per ton Hampton Roads (Norfolk, Va.) to Boston from 1912 to date of going to press. The coal prices f.o.b. Hampton Roads and on the cars at Providence and Boston for the same period are also shown in Fig. 1.

The behavior of prices (free coal) for other market centers fluctuated likewise[2].

Transportation of coal by ships and barges had already become serious when the Shipping Board assumed control of ships and shipping. The Northwest gets great quantities of its coal by boat from Buffalo. These ships carry wheat and ore going east and return to the Northwest loaded with coal. Because they could make three round trips instead of two, earning extraordinarily high rates carrying freight east each trip, their owners sent them west in water ballast.[3] The Northwest started its present coal year 3,000,000 tons short, by the way; but the Priority Board sent 375,000 tons more into that section this year than went into it last year, much to the momentary disapproval of New England.

Some of the great textile cities of New England have ordinarily depended upon a few ships to transport their coal from Hampton Roads to New England ports. The unprecedented shortage of bottoms for transocean trade greatly jeopardized the continuity of service of these industrial centers. The "Plymouth," one of the colliers engaged in supplying these cities, was reported sold to an allied government for $2,500,000. In July a new vessel was sold to the Italian government for five times its cost. Unless prevented by law, an owner will sell when he can get rich on a ship that has long ago paid for itself and that will bring a selling price unbelievably more than its original cost. This is why we need a shipping board to control ships and shipping.

It was this same kind of profiteering that made necessary the setting, by the President, of coal prices at the mines, which was done Aug. 21, subject to revision by the Fuel Administrator. The prices given in Table II are those now in force and inclusive of the 45c. per ton increase granted lately.

The Government recently acquiesced to a 45c. per ton increase at the mines. The exigencies of the fuel situation made it expedient to do so. On this ground, at least, it was justified. Refer to Curve 3, Fig. 1, and it will be observed that the price curve ends at September, 1917. Immediately the President fixed prices at the mines, the coal market for free coal became practically suspended. At first there were not even rumors of coal being sold at the mines for the prices prescribed by the Government; then one heard of such transactions now and then. There have been and are now rumors of other transactions the proof of which would—or

TABLE I. FACTORS CONTRIBUTING TO FLUCTUATION OF BITUMINOUS COAL OUTPUT DURING PERIOD OF WEEK ENDING JUNE 16, 1917, TO WEEK ENDING NOV. 17, 1917

(Compiled from Weekly Statements by the U. S. Geological Survey)

Week Ended	Total Tonnage Produced: Tonnage per Week	Total Tonnage Produced: Average per Working Day	Percent of Full Time Output: Produced	Percent of Full Time Output: Total Cost All Causes	Loss on Account of: Car Shortage	Labor Shortage and Strikes	Mine Disability	All Other Causes	No Cause Given
June 16	11,092,748	1,848,791	74.8	25.2	17.1	3.3	3.7	0.2	1.0
June 30	10,948,802	1,824,800	69.7	30.3	21.1	4.5	3.2	0.1	1.4
July 14	11,417,185	1,902,864	76.5	23.5	15.0	3.9	3.8	0.1	0.7
July 21	10,963,627	1,827,271	73.7	26.3	16.9	4.4	3.7	0.2	1.1
July 28	11,008,672	1,834,779	75.7	24.3	13.9	5.5	3.8	0.6	0.4
Aug. 4	10,439,865	1,739,977	75.8	24.2	13.6	6.2	3.4	0.7	0.1
Aug. 11	10,503,169	1,750,528	73.8	26.2	12.7	9.5	3.5	0.5	0.1
Aug. 18	9,831,075	1,638,513	67.2	32.8	10.6	18.8	2.4	0.6	0.4
Aug. 25	10,396,630	1,732,772	74.2	25.8	10.3	10.9	3.1	0.8	0.8
Sept. 1	10,787,867	1,797,978	77.1	22.9	10.3	6.9	3.9	0.8	1.0
Sept. 8	(a) 9,496,612	(a) 1,798,602	79.8	20.2	6.5	7.8	5.1	0.4	0.2
Sept. 15	10,795,357	1,799,226	78.0	22.0	9.8	8.0	3.0	0.9	0.2
Sept. 22	10,397,978	1,732,996	71.9	28.1	9.4	11.7	3.4	0.8	2.8
Sept. 29	10,916,113	1,819,352	74.3	25.7	10.8	8.1	3.7	0.7	2.4
Oct. 6	10,616,053	1,769,342	74.2	25.8	9.2	9.3	4.3	0.7	2.3
Oct. 13	10,766,977	1,794,496	76.9	23.1	13.0	3.7	3.5	0.6	2.3
Oct. 20	9,979,180	1,663,197	65.8	34.2	11.5	15.1	2.6	0.1	4.9
Oct. 27	10,688,313	1,781,385	74.9	25.1	14.8	5.9	3.8	0.3	0.3
Nov. 3	10,802,841	1,800,474	75.4	24.6	14.5	5.7	3.6	0.3	0.5
Nov. 10	11,116,356	1,852,726	77.8	22.2	15.3	3.6	2.7	0.3	0.3
Nov. 17	11,325,202	1,887,534	75.5	24.5	19.2	2.6	2.2	0.2	0.3
Nov. 24	(b) 11,260,490	(b) 1,876,748	....	....	....	....	....	....	....

(a) Difficult to calculate because of irregular observance of Labor Day. (b) Subject to revision.

Month	Total Bituminous Monthly Production: Total Year, 1916	Total 11 Months, 1917
January	46,596,094	47,788,086
February	45,186,515	40,312,112
March	43,821,604	46,669,614
April	33,628,164	41,812,836
May	38,903,759	47,119,756
June	37,741,972	47,105,589
July	38,113,105	46,070,880
August	42,695,735	41,170,739
September	42,098,831	52,393,927
October	44,807,205	42,050,523
November	44,927,817	44,504,889
December	44,097,744	....
Total	502,518,545	496,998,951 Total 11 Mo.

Total production for the first eleven months of 1917 shows a gain of 38,578,150 tons or 8.4 per cent. over 1916.

[1]Freight rates are "independent" and "company." Independent rates are those charged by ship and barge owners; company rates are those charged the coal companies using their own boats to transport coal sold by them.

[2]Free coal is coal on the market free to be sold to anyone; that is, it is not contracted for. In normal times 70 to 80 per cent. (some estimates are 70 to 90 per cent.) of the coal mined is contract coal, which sells at a lower price invariably than free coal. Now the conditions are reversed on account of real shortage at the points of consumption and because of panic buying.

[3]Federal Trade Commission Report, June, 1917.

should—put the participants in jail; namely, that coal is being sold at the mines for $6 per ton—the difference, say $3.75 per ton, getting to the seller by way of a bet that overnight Jupiter would swap his five moons for

TABLE II. COAL PRICES AT THE MINES AS PRESCRIBED BY THE GOVERNMENT

Prices per Ton (2,000 lb.) at the Mine

Region	Run of Mine	Prepared Sizes	Slack or Screening
Pennsylvania	$2.45	$2.75	$2.20
Maryland	2.45	2.75	2.20
West Virginia	2.45	2.75	2.20
West Virginia (New River)	2.60	2.85	2.35
Virginia	2.45	2.75	2.20
Ohio (thick vein)	2.45	2.75	2.20
Ohio (thin vein)	2.80	3.05	2.55
Kentucky	2.40	2.65	2.15
Kentucky (Jellico)	2.85	3.10	2.60
Alabama (Big Seam)	2.35	2.60	2.10
Alabama (Pratt, Jaeger and Corona)	2.60	2.85	2.35
Alabama (Cahaba and Black Creek)	2.85	3.10	2.60
Tennessee (Eastern)	2.75	3.00	2.50
Tennessee (Jellico)	2.85	3.10	2.60
Indiana	2.40	2.65	2.15
Illinois	2.40	2.65	2.15
Illinois (third vein)	2.85	3.10	2.60
Arkansas	3.10	3.35	2.85
Iowa	3.15	3.40	2.90
Kansas	3.00	3.25	2.75
Missouri	3.15	3.40	2.90
Oklahoma	3.50	3.75	3.25
Texas	3.10	3.35	2.85
Colorado	2.90	3.15	2.65
Montana	3.15	3.40	2.90
New Mexico	2.85	3.10	2.60
Wyoming	2.95	3.20	2.70
Utah	3.05	3.30	2.80
Washington	3.70	3.95	3.45

Earth's one. Although the selling market was practically suspended, the production at the mines continued heavy as shown by Table III.

If the Government had said to the mine operators, "Your production must from now on be at least 75 per cent. normal under penalty of confiscation"; to the railroads, "You must supply so many cars to such and such mines per certain unit of time, under a prescribed penalty"; to the Shipping Board, "So many tons carrying and towing capacity for coal must be available alongside at such and such ports during such and such units of time"—if these and the best that could be done to insure continuity of labor were provided along with price-fixing, there would have been no such severe conditions as we now experience. But a democracy suffers from inertia in a sudden and great emergency. Therefore much will be overlooked by the kindly disposed.

Coal delivered to the consumer should cost A + B + C + D.

A = Government prescribed price at the mine (see Table II);

B = Freight charge plus 3 per cent. war tax (inquire of the railroad);

C = Broker's or jobber's percentage (15c. per ton);

D = Hauling or cartage and rehandling (depends on local conditions).

This does not refer to coal contracted for prior to Aug. 21, 1917.

The writer could give a table showing the freight rates from the chief coal fields to the chief centers of distribution; but it would be of general value only, as state public-service commissions cause such rates to vary from the rates prescribed by the Interstate Commerce Commission. It is quite certain that the railroad situation would improve if all of the various state committees were to relinquish control and thereby place the railroads under one central authority.

Control of Coal by Foreign Governments—The coal mines in the United Kingdom have been controlled by the British government since about January, 1917. England went through much of the same turmoil we are passing through before she became convinced that a coal controller with practically absolute power over production, transportation, distribution and prices, was vitally necessary to the winning of the war. It should be realized by us in America that England has the great advantage that her industries are not so distant

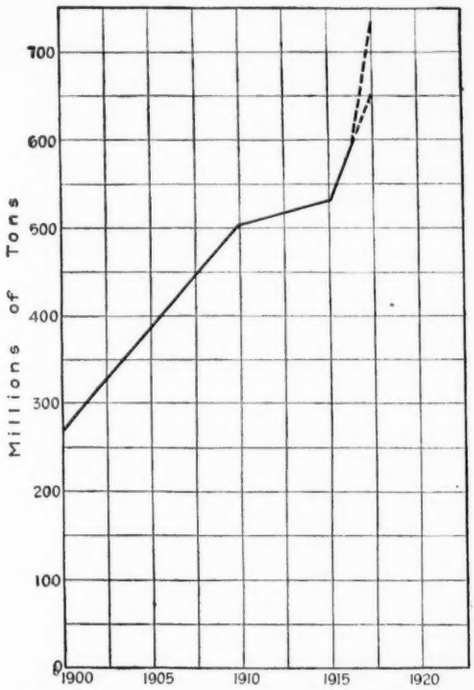


FIG. 2. WHERE COAL PRODUCTION WILL LIKELY REACH—AND WHERE IT SHOULD GO TO MEET INCREASED DEMANDS

from the coal fields as ours are. Dividends to stockholders, as well as all profit distribution, must be approved by the government. Wage and other agreements between miners and operators must be approved by the government. The army, navy and all munition plants and railroads are given preference in supply and allotment of cars. Profits above a specified figure based

TABLE III. ESTIMATED WEEKLY BITUMINOUS COAL PRODUCTION

(From Geological Survey Bulletins)

Week Ended	Total Bituminous Production Including Coal Coked, Net Tons: Total for Week	Total Bituminous Production Including Coal Coked, Net Tons: Average per Working Day
Aug. 4	10,439,865	1,739,977
Aug. 11	10,503,169	1,750,528
Aug. 18	9,831,075	1,638,513
Aug. 25	10,396,630	1,732,772
Sept. 1	10,787,867	1,797,978
Sept. 8	9,496,612	1,798,602
Sept. 15	10,795,357	1,799,226
Sept. 22	10,397,978	1,732,996
Sept. 29	10,939,645	1,823,274
Oct. 20	9,979,180	1,663,197
Nov. 3	10,802,841	1,800,474
Nov. 10	11,116,356	1,852,726
Nov. 17	11,343,538	1,890,590
Nov. 24	11,260,490	1,876,748

on an average of any two years out of 1911, 1912 or 1913 are subject to an excess tax of 50 per cent. Mine workers cannot enlist in the army or navy unless approved by the government.

The Rhenish-Westphalian Coal Syndicate, of Germany, in 1915 delayed a little too long in reaching an agreement as to how hard it would rub in into the consumer, whereupon the Imperial Federal Council gave the syndicate from July 12 to Sept. 15 to make up its

mind or have all its coal mines pooled and the syndicate converted into compulsory producing companies. The companies in the syndicate, which were delaying matters, immediately reached an operating agreement with their fellows. The government now controls the coal situation, even its consumption. The gas and electric companies cannot make new connections between prospective consumer and the mains unless approved by the government. Like much of Europe, the gas in many parts of Germany is available, to domestic consumers at least, for only a few hours each day.

Coal Has Temporary Priority

As this article goes to press the Fuel Administration requests the coal producers to serve for a period of thirty days a preferential list of consumers engaged in industries vital to the war. The Fuel Administrator has rejected a proposal to cease shipment of coal to nonessential industries. Dr. Garfield and Mr. Hoover are having a flare-up over preference for coal over food and vice versa, each giving good reasons why his supplies should be moved first. Judge Lovett, of the Priority Board, will decide what is to be done, though Dr. Garfield has the consent of the Eastern roads to sidetrack almost everything to let coal go through for the next thirty days. Senator Newlands, whose committee has been investigating the railroads for nearly a year, is ready to recommend that the Government give a billion dollars to help maintain the roads at an efficiency equal to that which has so far been maintained. It is likely the roads will get it and that more thorough Governmental control will follow.

To avoid congestion and serious delays on account of winter, with its cold and snows, is a problem that makes all apprehensive. The number of freight locomotives in shop for repairs is 7.6 per cent. less than this time last year, and the number of cars "tied up" for repairs is 6 per cent. less this year than last.

Below is part of Priority Order No. 5 to all railroads, issued by the Priority Shipments Board and which went into effect Wednesday, Dec. 12:

Preference and priority in movement only to coal for current use but not for storage, consigned direct (and not subject to reconsignment) to hospitals, schools and other public institutions, retailers of coal for use in supplying domestic consumers only; and to coal, coke and raw materials for current use but not for storage, consigned direct (and not subject to reconsignment) to blast furnaces, foundries, iron and steel mills, smelters, manufacturers engaged in work for the United States Government or its allies, public utilities (including street and interurban railways, electric power and lighting plants, gas plants, water and sewer works), flour mills, sugar factories, fertilizer factories, and shipbuilders; also shipments of paper, petroleum, and petroleum products.

This order shall not affect priority order No. 2, dated Oct. 27, 1917, relating to open-top cars; priority order No. 3, dated Nov. 2, 1917, relating to movement of coal from mines in Utah and Wyoming.

Priority of coal supply is getting the attention of many engineers these days. By priority here is meant priority of supply to those consumers of fuel most economical in its use and who are engaged in the manufacture of similar products. The desirability of this is unquestioned; but the job of practicing it without stirring up a veritable mess that might result in serious decrease in production of needed commodities and in financial unbalance is obviously difficult.

Many admirable things are being done to encourage economy in coal consumption, among which are the efforts to educate firemen. This at best produces results slowly. The big way to attack the problem is to first leave no stone unturned to promote the greatest possible production at the mines, and give and create every facility for transporting the coal to the points of consumption. Education *shall* be secondary; the exigencies of the situation *wills* it so.

Now is an excellent time to institute bonus systems in boiler rooms. The incentive of more money is great in a time of high prices, and with coal prices high it is doubly so. No one can give particulars for bonus methods that will be satisfactory in all plants. Let the amount to be paid as bonus be based upon the cost of fuel, the ease with which decreased consumption per unit of output may be effected, and the number of men to participate in the bonus. From here and there one hears it said that firemen should be immediately examined and licensed by the Government. To one acquainted with present boiler-room labor conditions, such talk is asinine. Most every chief engineer knows he shall take what he gets these days.

The situation, coal and rail, seems to demand the following:

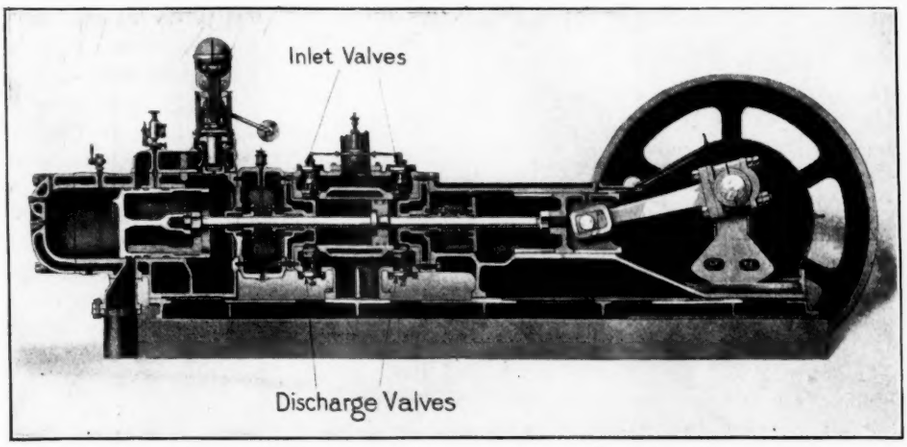
1. Absolute control (not ownership) of the coal mines and coal output.
2. Government approval of coal prices, profits and wage agreements between miners and operators.
3. Supervision of mine employees as related to enlistment in and drafting for war service.
4. Government control of coal distribution, with priority of supply to vital industries.
5. A Chief of Fuel Economy (a recognized authority on boiler and furnace practice) under the Fuel Administrator to organize and coördinate the work of all the various committees now existing and proposed to assist in economizing coal.
6. Continued and more thorough control (not ownership) of all railroads aiming at unification of all roads.
7. Immediate government loan of sum sufficient to rehabilitate railroad equipment together with a just rate increase for freight and passenger service. (The idea is to effect a compromise between the English and American methods.)
8. Regulated priority for definite period, under government approval, of materials of construction for railroads.
9. Government approval of all wage, hours-of-labor and operating crew agreements between labor and road owners; approval of enlistment and drafting of employees into war service.
10. Agreement of railroad labor with the Government not to strike or otherwise interfere with the continuous and efficient operation of the roads until two years after declaration of peace by our Government; Government-guaranteed prompt payment of bonus to labor to meet increased cost of living.
11. Government approval of profits and railroad finance.
12. Continuance of the Priority Board.

Gasoline-Driven Air Compressor

Air compressors in large plants are generally driven by steam and are either direct-connected or belt-driven, usually the former. In smaller units not only is steam used, but internal-combustion engines are also employed as the driving power.

There are many instances where it would be neither economical nor practical to run a long steam-pipe line to a steam-driven compressor, and for such and other isolated cases gas- and gasoline-driven compressors have been built in stationary, portable and semiportable units.

A section through a gasoline-driven compressor built by the Chicago Pneumatic Tool Co., Chicago, Ill., is shown in the illustration. The compressor is of the horizontal, straight-line, single-stage, double-flywheel, inclosed-frame type. The power and air cylinders are connected in tandem. The three-port power cylinder is operated on the two-cycle low-compression principle with high-tension electric ignition. A pressure governor regulates the amount of gasoline that is admitted to the cylinder. Water jackets cover only the parts of the cylinder where combustion takes place, so as to eliminate unequal expansion. The cylinder head is a separate casting and is water-jacketed. In operation, during the scavenging and exhaust period, compressed air from the crank end of the cylinder works through the pure-air transfer port into the combustion chamber, thus sweeping out the burned gases through the exhaust outlet. The pure-air inlet is closed by the piston, and as the piston advances along the compression stroke, the exhaust outlet and pure-air transfer ports are closed by it.



SECTION THROUGH GASOLINE-DRIVEN AIR COMPRESSOR

The unit is guaranteed to run satisfactorily on any grade of gasoline and is designed for rough, heavy duty. The main feature of the air end of the machine is the use of simplate valves (see *Power*, Nov. 2, 1915, p. 615). They require no lubrication and are interchangeable.

The main frame is inclosed, and the crosshead guides are bored. Removable oil-tight cover plates and shields provide access to the working parts.

The crosshead is of the single-piece box pattern without adjustable shoes, and it overtravels the guide nearly one-half its length at each end of its stroke, thus bringing the longitudinal wear on the guide on an even straight line through its length.

A combined speed and pressure governor is used in conjunction with the differential unloader on the gas-driven compressor. Together, these automatically limit the speed of the machine, maintain practically a constant air pressure at all times and reduce the load to a minimum when there is no demand for air. An unloader controls the air supply by permitting the opening of the air-inlet valves and allowing the air in the cylinder to return to the atmosphere whenever the pressure in the receiver exceeds a predetermined amount.

Direction of Fan Reversed

By E. C. Parham

Electric generators and motors of today are much lighter than those of the same rating of earlier designs. This is largely due to a better understanding of the conditions required for effective ventilation and heat radiation. The rating of almost any electric machine can be materially increased by means of fans and by operating at higher speeds, and these are two important features embodied in machines of modern design. Fans at high speeds move much more air than they do at low speeds, and carrying away heat is essentially a matter of moving large volumes of cooling air across the heat-generating areas. Also keeping the various parts cool minimizes the amount of heat generated by limiting the increase in resistance of the conductors involved. The effect of artificial cooling can perhaps be best demonstrated as follows:

If a given machine is operated at its rated load, under normal conditions, and its temperature measured after the machine has run long enough for its temperature to become constant, then the test repeated with all conditions the same excepting that a current of air from a fan is directed upon the parts that show the greatest tendency to heat, the final temperature of the machine after the second test will be much lower than that after the first. This shows that carrying away the heat is as important as preventing its generation. Heavily overloaded machines that could not be immediately relieved in any other manner, because of prohibitive losses of production, have been saved by directing a current of cool air from a fan or from an air hose upon them. There are cases of record where even a stream of cold water has been used for limiting the temperature of inclosed motors.

The fan for a modern machine is, in many cases, included in the design of the machine itself, but the possibility of not getting the full benefit of a modern ventilating device is illustrated by the following experience:

In the course of making some tests on a large motor-generator set, it was discovered that the temperature of the units exceeded what was to be expected at the existing load. The higher temperature would have done no harm, but where large units are involved the matter

of efficiency is a very important one and increased heating means decreased efficiency. It was therefore decided to locate the cause of the discrepancy.

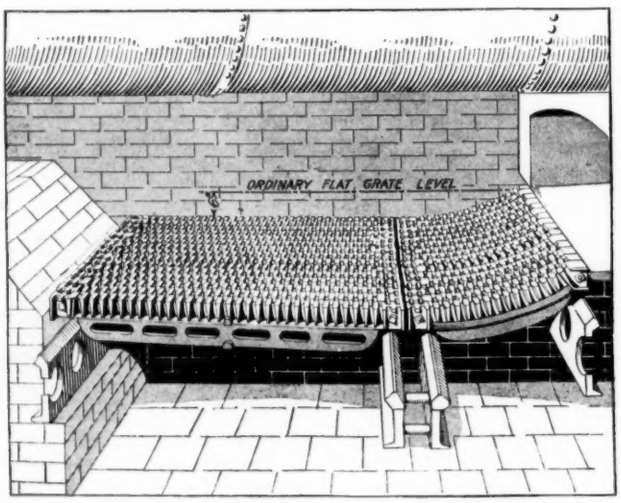
Preparations had been completed for making careful tests with checked instruments, when someone noticed that the set was operating in the direction opposite to that for which the ventilating fans had been applied. The fans were of a design that gives a high efficiency of air movement in one direction of rotation and a low efficiency for the opposite direction. On reversing the direction of rotation, normal temperatures obtained, which again shows the effectiveness of modern electrical-machinery ventilation.

States Basket-Type Sectional Grate

There are many old installations of horizontal return-tubular boilers, as well as some not so old, in which the distance from the grates to the boiler shell is very short, which is contrary to the modern practice of allowing ample room for the combustion of the gases to take place before the flame comes in contact with the comparatively cool surface of the boilers.

The application of the States' basket-type sectional grate illustrated herewith will increase the distance from the grates to the shell from 4 to 6 in., depending on the amount of drop in the curved grate used at the front end of the furnace; and this is accomplished without change in the fire front or dead-plate arrangement of existing installations.

This grate will also give a horizontal slant to the entering air at the front of the fire, thus tending further to prevent the flame from impinging directly against the boiler shell and to cause the mixture of heated air and gases to sweep over the burning fuel close to the surface, which greatly improves the combustion and tends to reduce smoke formation.



APPLICATION OF BASKET-TYPE GRATE

The rest of the grate surface is of the States sectional type, which was fully described on page 858 of the Dec. 21, 1915, issue of *Power*. It consists of inverted pyramidal stools for supporting the fire with an air space surrounding each stool. The air spaces may be varied in width to suit the class of coal being burned; the standard width generally used for run-of-mine coal is ⅜-in., which gives slightly over 50 per cent. draft area through the grates.

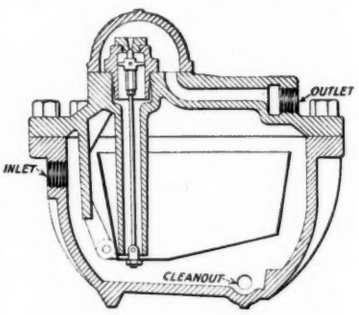
The under structure of the grate does not come into actual contact with the fire and is ventilated to insure keeping the grate comparatively cool.

This grate is manufactured by the Eureka Manufacturing Co., Lincolnton, N. C.

Fisher Steam Trap

Steam traps, of which there is a large variety, are used to remove condensation from heating coils, pipe lines, separators or other apparatus where water is likely to collect. Another one to be added to the list is the Fisher steam trap (No. 33), manufactured by the Fisher Governor Co., Marshalltown, Iowa.

The essential features of this trap are the body, which has heavy reinforcing ribs, a cast-iron open float and a discharge valve. The trap body contains an inlet opening, but the discharge valve and outlet are placed in the cap; arrows are cast to show the direction of fluid travel. A section through the trap is shown in the illustration. The bucket bearing is of brass to avoid corrosion.



SECTION THROUGH FISHER TRAP

When in operation the water accumulates in the body of the trap, and when it reaches the high water point it overflows into the cast-iron bucket; and as the water continues to flow into the trap, the bucket is submerged and, in descending to the bottom, opens the valve in the top of the trap. The pressure in the trap discharges the water through the outlet until the low-water point is reached, when the float lifts, closing the valve, and the cycle is repeated.

Owing to the construction of the bottom of the bucket, a water seal is formed to prevent the escape of steam. A cleanout opening is provided for blowing out any accumulation of sediment.

This trap will lift water two feet to each pound pressure in the trap and is built in capacities from 495 to 6500 lb. of water per hour. The valve and seat are renewable without disturbing the pipe connections. A baffle plate prevents the entering water from disturbing the action of the bucket.

It has been found that a difference in temperature of one degree Centigrade between the opposite sides of an inch cube of copper will allow a heat flow 2500 times as great as with a corresponding tube built up of oiled tape. And a one-inch cube of wrought iron, which is considered a poor electrical conductor, will conduct 400 times as much heat as the block of insulation.

The following mixture makes a paint that will withstand heat admirably. Dissolve 6 lb. brown soap in 12 gal. water, add 18 gal. Japan oil and 80 lb. graphite, heat and and stir to a uniform consistency.

Editorials

Man Power

THERE is plenty of coal in the ground. When one buys a ton of it, he pays not for the substance, but for the service of finding, mining, preparing, transporting and distributing it. Potatoes are still far from cheap, but there are bushels yet undug, and acres of land upon which thousands of other bushels might have been raised if the man power had been available.

Aside from raw material in its crudest unwon state and native position, everything is the product of labor. The difference between a steam engine set up and running upon its foundation and the ore from which it was made, lying still hidden in its mother vein, is attributable to labor and to nothing else. Capital and all forms of overhead are reducible to the products of human labor or payment for service rendered, which is simply a method of exchanging one form of labor for another.

This is no new thought. It will stand elucidation and demonstration, but this is not the time and place for such a thesis. It is stated here for the purpose of deducing from it an admonition or behest of urgent present application.

The stupendous struggle in which we are engaged, comparable to nothing in the history of the world, beyond the imaginings of the writer of the wildest fiction, fraught with such tremendous possible effects upon the development and progress of the race, will be decided by the adroitness, promptness and effectiveness with which man power is used. Neither side has a decisive advantage in position, nor in accessible raw material. The side that can get the most people at work, doing with the greatest efficiency the things that will count most, will win the war, with all that that winning means.

Behind man power in the military sense, the conservation and adroit employment of which is a function of generalship, stands the man power—the mankind power, for the women contribute a big part of it—of the noncombatant; and this must be employed not only in furnishing the munitions of war and the support of the fighters, but in supplying its own necessities, for a people that can no longer make its own living is already defeated. The shortage of this kind of man power is already beginning to make itself keenly felt. It is within the ability of every man, woman and child to help in conserving it in making the restricted supply available for more quickly ending the cataclysm of carnage and misery that is wrecking lives and breaking hearts all over the world and hurling into a whirlpool of destruction the product of millions of man-hours of human toil.

Every ton of coal that you burn that might be saved involves unnecessary work on the part of a miner and his helper, of the timbermen who shore up the advancing burrow, the woodmen who hew the lumber for their work, and all who are concerned with its transportation to its point of application; of the men and plant that make and market and transport the explosive with which the coal is blasted out; of the car and crew that drag it to the tipple; of the elaborate hoisting machinery that lifts it to the surface and the men who operate it; of the men who run the boilers, and all the men who are concerned with the mining of the coal to furnish steam to run the hoists and air compressors; of the breaker crew, of the drill gang and engines by which it is set upon the siding. You have occupied unnecessary car capacity, of which there is such a shortage, locomotive capacity, of which there is such a lack, and compelled the needless burning of other coal to drag yours across the country. You have employed our scanty man power in the operation of this train in the carting of this coal to the dealer's yard and to your home or plant; you have made unnecessary work for all the elaborate middleman system of distribution, and have played, at your own cost, into the hands of the dealer who makes increase in demand the excuse for a raise in price.

True, your little ton of coal would have added but a tithe to the labor of the timbermen, the trainmen and others, but add to it the saving that you might effect, not in your own bank account but in the demands upon the man power of the country, by wearing your overcoat another season, by not driving your automobile for mere pleasure, by restricting your table to only enough of the most plentiful and easily produced food products, by avoiding the purchase of nonessential things the production and marketing of which involves human labor. And then multiply this by the similar saving that might be made by the hundred million other inhabitants of this land, and you would have a conservation of man power, which, if rightfully applied, would bring the war to a swift and victorious conclusion and leave you with resources husbanded at the expense of a little more than the ordinary thrift and the temporary sacrifice of easily dispensable indulgences.

War Necessities First

THE entrance of the United States into the war against Germany has changed the conditions governing the regulation of business, which is so generally good that the demand for many articles of finished product is greater than the capacity of the factory or than the raw material at hand can produce. Therefore there must be a curtailment in some enterprises not closely related to the maintenance of war necessities.

There are several reasons for this, the most important being: A serious coal shortage; lack of labor absolutely necessary to carry on the work of building ships, making war supplies, and that required to produce the necessities of life; and then there is the congestion of the railroads, the demands upon which are greater than their capacity to handle.

These three factors are in themselves sufficient to justify the Government in prohibiting the use of open railroad cars for any purpose other than that of handling coal from the mines to the consumer. Naturally, any project that cannot be carried to completion because of war necessities is doomed to an indefinite postponement. Naturally, too, those who are interested in such contemplated projects feel that their particular branch of work is being discriminated against.

Take, for instance, the Federal embargo on road-building material transportation in relation to the use of open cars for carrying such building material as rock, gravel and cement. This, of course, is a detriment to road construction, but what if it is? Good roads are necessary, but there are other requirements that are of vastly more importance. For instance, no one will be harmed if the fifteen-million dollar road project recently forced upon the State of New Jersey is indefinitely postponed. Such a postponement or abandonment altogether would release labor, railroad cars and the coal necessary for the production and transportation of the various building materials, which could well be utilized where it would work to better advantage to the Government needs.

The same applies to the highway project of California, where the state highway commission has protested against the Federal car embargo and has requested that it be removed so far as the requirements of the state-highway work are involved, because the contractors engaged upon contracts aggregating about four million dollars will be put to great pecuniary loss and because much of the road program upon which the state is engaged will have to be postponed indefinitely.

It is better by far to postpone all unnecessary work that will interfere with the successful carrying on of the war preparation in which the Government is engaged. It is better, if necessary, that the state and the contractors lose a few thousand dollars rather than that one American soldier should be killed because there was lack of the necessary munitions or other supplies.

By all means keep war supplies going to the front. Other considerations can play second fiddle for a while. It will do no harm.

The Block Plant

From an Address to the New England Association of Commercial Engineers

THERE are many things which you can do for yourselves and for one another, united as you are in an organization of this kind. Some of them you have already done; others you are doing and planning to do. I am especially interested in the stand which is being taken here in Boston with regard to the central station. It is a situation which interests all of us and which we must look squarely in the face. The passing of the isolated plant means the passing of a lot of your business, but if the running of many small industries from a central power plant is the social-economical thing to do, it will be done and no blind opposition or senseless wriggling under the squeezing process will stop it.

But is it? If you were a potentate and owned this city and everything in it, would you put in a single large power station and run everything from it, or would you have a multiplicity of small plants, one for each industry? In my opinion you would do neither. You would group neighborhood plants so as to get the economy of aggregation and the averaging effect of multiple demand, and to use the steam rejected by the engines for heat and other useful purposes. There are many places where central-station current is logical, economical and the right thing to use. There are many places where it is a misfit and where it costs the customer more than he could make it for, and very much more than he and his neighbors upon the same block could make it for if they would put a power plant in one of the courts or cellars of the block and heat, light and drive the whole block from it, each tenant or user paying his proportionate share.

How would this be for a legitimate undertaking for an association of commercial engineers? To select a representative city block, find out the requirements of all the tenants in power, for light, heat and refrigeration and how they synchronize or neutralize one another. Find out how much of a plant would be required to meet the maximum demand with a safe reserve; what that plant would cost; what it would cost to run it and to pay interest, insurance, rent, taxes, depreciation, etc., and see if you could not make it mightily interesting to the owners and tenants in that block to enter into some such a coöperative arrangement. If you have here laws or underwriters' rules prohibiting the carrying of current through building walls or from building to building, it is another legitimate activity for your organization to insist that regulations be based upon the physical risk involved and not upon who owns the properties connected. I can see where a campaign of this kind, industriously and intelligently carried out, would lead to much business for you, much saving for your customers and much future usefulness for your association, the members of which are eminently fitted with the essential knowledge of machinery required, the cost, etc., and particularly imbued with the strongest possible motive—the commercial—to carry it through.

What Are We Fighting For?

THERE are those who, in spite of the President's message of April last declaring that a state of war exists between this country and Germany, profess not to know what we are mixing up in this fight for anyhow. To all such we recommend the reading of the address which Ex-President William H. Taft delivered to the American Society of Mechanical Engineers at its recent annual meeting.

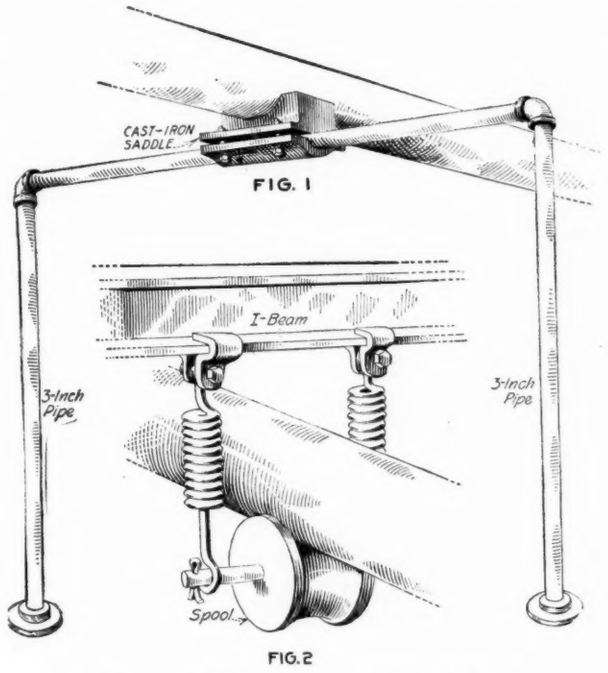
If the reading of the message of the President declaring the war and the reasons for it, and the reading of this ex-President's message elucidating these reasons is not enough not only to inform anybody what we are fighting for, convince him that we ought to have been fighting for it long before we were, and imbue him with a possessing desire to get into the scrap, we are sorry for that somebody that his lines have been laid in America, and sorry for the United States that such spawn should have fastened itself upon her.

Among other things, the war is the Great Demonstration that technical education without that which cultivates moral obligations and the ennobling impulses is a cancer in the vitals of civilization.

Correspondence

Pipe Hangers To Eliminate Vibration

An engineer who plans to run a high-pressure steam line through the basement of a building in which laboratory work requiring delicate mechanisms is in progress



FIGS. 1 AND 2. PIPE-HANGER DEVICES

Fig. 1—Floor Support Where Space is Ample. Fig. 2—Double-Spring Hanger for Limited Headroom

on the upper floors is considering the use of the devices shown in the accompanying drawings to avoid the effect of vibration. The boiler plant is housed in a sort of lean-to structure attached to one side of the main building, and two high-speed engines, to which the proposed line of pipe is to be run, occupy a wing projecting from the opposite side.

The arrangement shown in Fig. 1, in which the steam main rests on a saddle clamped to a horizontal piece of pipe, will be used in the basement. The 3-in. uprights will be threaded into flanges embedded in the concrete floor. The flexibility of the uprights is depended upon to absorb any lateral vibration of the main for the section that it supports.

Lack of sufficient space beyond the basement wall will prohibit use of this form of support, so the device shown in Fig. 3 has been contrived.[1] This consists mainly of an upright pipe, with a smaller pipe, capped at both ends, telescoped inside of the larger one and resting on a helical spring. The method of adjusting the height of the support is indicated in the drawing. As a safety precaution, this single-standard support is to be supplemented by a common style of hanger suspended from the ceiling. By means of the adjusting screw the main will be raised just enough to keep the hanger from bearing any of its weight; but in the event of failure of the spring the hanger will take the entire weight with but a slight settling of the main.

In the boiler house, where support from beneath is impracticable, the main will be hung with spring hangers. Where headroom is ample, the form shown in Fig. 4 will be used; but in one place, where the space between the main and the ceiling is scant, recourse will be had to the double-spring style of hanger shown in Fig. 2.

The check-nuts indicated in Fig. 4 are intended as a safety device for guarding against possible fracture of the spring. In the event of this occurring, the pipe would drop only about an eighth of an inch before its weight would be taken by the check-nuts on the side bolts.

With the style of hanger shown in Fig. 2, safety will be secured by rigging up a reserve hanger of the

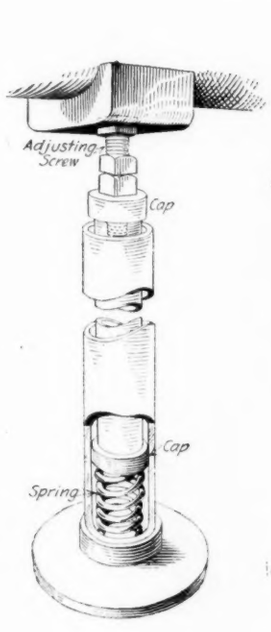


FIG. 3. FLOOR SUPPORT FOR RESTRICTED SPACE

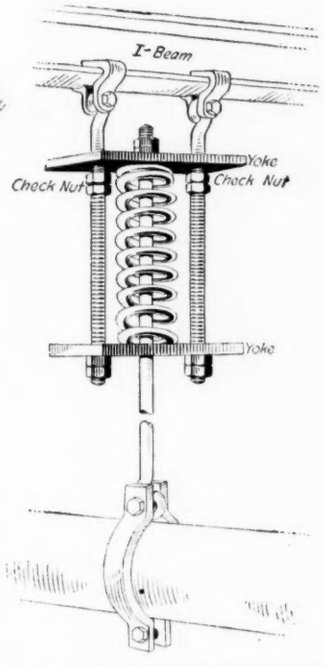


FIG. 4. SIMPLE SPRING HANGER WITH SAFETY DEVICE

ordinary rigid type close by, as in the case of the single-standard support, adjustments being such as to barely ease the weight of the main off the supplementary hanger.

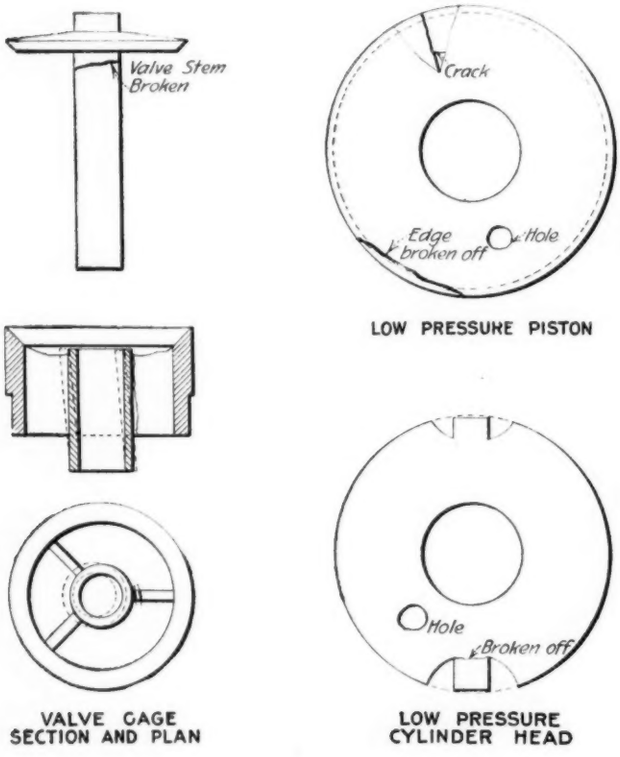
A. J. DIXON.

St. Louis, Mo.

[1] A shock absorber, consisting mainly of a spring, caps and insulating material, is used by C. F. Wendland, consulting engineer, New York City. A description of the absorber and one of the installations where it is employed was published on page 8 of the Jan. 2, 1917, issue of "Power."—Editor.

An Air-Compressor Accident

One morning the watch engineer heard a tremendous knocking and pounding in one of our three-stage 8 & 5 & $2\frac{3}{8}$ x 6 compressors and as quickly as possible cut it out of service. When he pulled the belt off, he could not turn the machine over by hand. We took the low-pressure intake-valve cage out, and as the cage dropped out it was followed by several pieces of cast iron that had been the lug on the head of the cylinder against which the valve tapped on its rise from the seat.



CONDITION OF DAMAGED PARTS

We then removed the cylinder head and found the valve stem broken as shown and the head of the valve jammed into the low-pressure piston so that it had to be knocked out with a chisel. There was also a hole in the cylinder head similar to that in the piston, and the piston was cracked and the edge shattered where the piston was forced against the cylinder wall before it could be stopped. The illustrations show in a general way what happened to the valve, valve cage, piston and cylinder head. The dotted lines show how the valve-stem guide was pushed to one side at the top and that one of the supporting webs was cracked.

To avoid waiting for repairs from the factory, we used our oxyacetylene welding machine and filled the holes in the piston and cylinder head, chipping a V-shaped groove to take out the crack in the piston and refilled it with the welder. We then put the piston in the lathe and turned it down so that it would fit into the cylinder as it would not reënter the cylinder after being heated, having expanded and set nearly $\frac{1}{16}$ in. oversize. The piston was heated in a slow fire to a dull red to take out all strains and allowed twelve hours to cool in lime. I chucked the valve cage in the lathe and bored out the guide till it would square up with the valve seat, then made a valve out of a piece of shaft steel, with a larger stem to fit the bored-out guide. It is somewhat of a mystery to us how the valve got into the cylinder, as we have since examined the other compressors and it seems impossible for them to do so. By the way, those repairs arrived two months after they were ordered.

F. C. WILLIAMS.

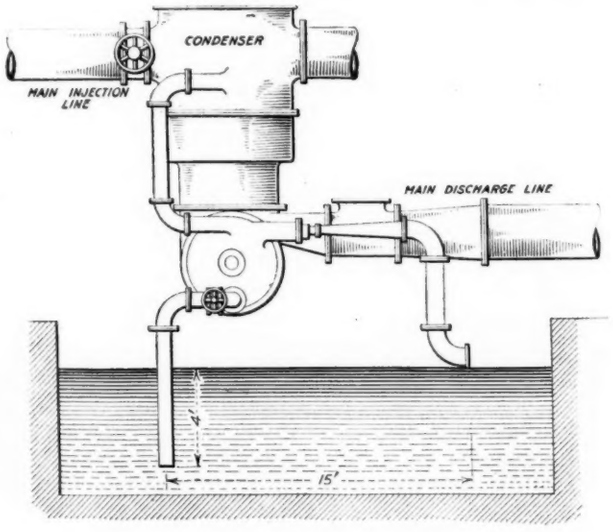
Acme, Texas.

Will Change in Water for Air Pump Be Good or Bad?

The writer had an experience similar to that described by L. F. Forseille in the Nov. 20 issue. We piped up the air-pump water from the main discharge, and the vacuum went down about two inches as a result. I concluded that we were evaporating the warmer water in the air pump rather than pumping the air out and that the vapor from the warm water filled the space that the air should occupy.

The way we got around our trouble was to install a separate tank for the air pump. The water from the air pump does not heat up appreciably, and the air pump can discharge into a tank that gives the water enough surface to liberate the air. We take the water out of this tank and use it in the air pump again. The water does heat up a little bit in going through the pump, and we find that it takes some cold water to keep the air-pump water cool.

In putting in this tank, it is necessary to have it deep enough so that the bottom end of the air-pump suction pipe will be about four or five feet under water. The discharge should go into the tank on a level with the surface and make as little fuss on the surface as possible. The water leaving the discharge had to flow through the tank fifteen feet before it could enter the suction to give the air a chance to be liberated. Another thing to be careful about is not to put the discharge up too high. I believe that the manufacturers' advice is good and should be followed.



SUGGESTED CHANGE IN PUMP CONNECTIONS

I have added a suggestion of the way the tank might be arranged, as shown in the illustration.

Brookline, Mass. HAROLD S. JOHNSON.

The Crane Was Charged

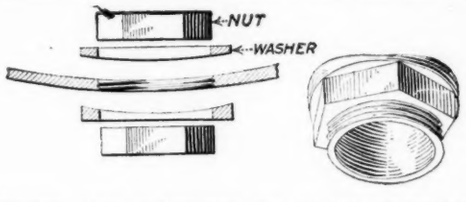
The advisability of grounding the neutral of the low-voltage secondary of transformers, the primary of which is 1100 volts or more, is not open to question, where the secondary supplies circuits that operators are liable to come into contact with. In such cases the secondary neutral is grounded in order to limit the potential to which operators may be exposed should a short-circuit occur between the high- and low-tension windings of the transformer. In order that such a ground may afford the degree of protection that it is intended to, it is essential that the ground be an effective one. It is also necessary that the containing structure of an electrical device be effectively grounded, so that a fault ground between the container and one of the windings will cause the fuses to blow and relieve the dangerous condition. If a fault ground is of too high resistance to admit sufficient current to blow the fuse, the fault will be a menace to personal safety unless the container of the affected device is effectively grounded.

An operator complained that his crane was so heavily charged that it was dangerous for his men to stand on the ground and handle the loads on the hook. An inspector who investigated the conditions was misled by statements to the effect that all the trouble was in the hoist motor, and considerable time was spent in trying to locate a ground there. Inspection was discontinued for a few minutes so that a shipment could be loaded upon the cars. During this time the inspector remained on top of the crane, and he noticed smoke coming out of the transfer motor. As soon as it was practicable, the motor was disassembled and the rotor was found to be rubbing a stator coil that extended above the others. After pushing the raised stator coil down, no more trouble was experienced. Had the crane structure been effectively grounded, the fault could not have been instrumental in giving a shock to a man who stood on the ground and touched the crane hook.

Brooklyn, N. Y. E. C. PARHAM.

Small Pipe Connection to Tank

We had several steel tanks, and it became necessary to make some additional small connections, for which no bosses or flanges had been provided. As the matter was urgent, the tanks were tapped and threaded for the 1-in. pipe connections. Some of them held tight and some leaked considerably, but we stopped the leaks by



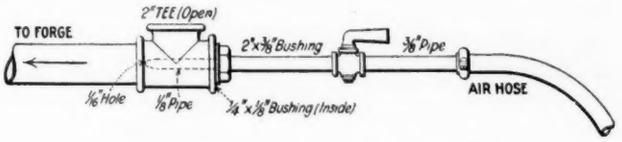
LOCKNUTS AND WASHERS ON TANK CONNECTIONS

means of two locknuts and packing washers, as shown in the illustration. The washers were made of fairly hard packing and were flat on one side, while the other side was shaped to conform to the contour of the tank. The locknuts were then pulled up tight on each side, making an entirely satisfactory joint.

Philadelphia, Penn. M. A. SALLER.

Portable Air Blast

A "good hot fire" is often wanted in places remote from the fan-blast system for heating rivets, flanging and a hundred and one different jobs. The simple device shown in the illustration is made of standard pipe fittings, and by its use the amount of high-pressure compressed air used is trifling, as the greater part is



COMPRESSED-AIR FORGE BLOWER

supplied by the outside air which rushes in at the open side of the tee. The principle involved is old, though this application may be new to many. When made of the correct proportions, such a blower will use comparatively little high-pressure air and give satisfactory service. WILLIAM FORRAY.

Brooklyn, N. Y.

Multi-Drum Boiler Equalizer Pipe Plugged

Recently, a new 250-hp. water-tube boiler was installed in one of our plants which had at that time four other boilers operating. The boiler has two drums, which are connected together near the back end by a cross-pipe having a flanged outlet for the main steam connection. The water column on the steam-pressure gage was connected to the left drum.

When starting up the boiler for the first time, it was filled to about half way and a fire was started in the usual manner. The pressure gradually crept up to 110 lb., which was the line pressure, at which time the boiler was cut in on the line. As soon as the valve connecting the boiler to the line was opened, the water-level rose rapidly past the top of the water column. The column was blown down several times and the try-cocks opened to make sure that the water column was working properly. The boiler was shut down and a water column purchased and installed on the right-hand drum; the column on the left drum remained in place. The boiler was again brought up to line pressure and the two water columns carefully watched. The water level in both columns remained the same until the boiler was cut in on the line, when the water rose in the left column and disappeared entirely in the right column, so that nothing but steam was obtained from the bottom try-cocks. It was found impossible to bring the water back to the proper level by manipulating the fires. The writer then realized that this difference of level was caused by unequal pressures in the two drums and that it must be due to an obstruction somewhere.

The cross-pipe between the two drums was the first place examined, and there the cause of the trouble was located. At the right side of the main steam connection was found some core sand that had not been removed from the casting. This sand was very hard and formed

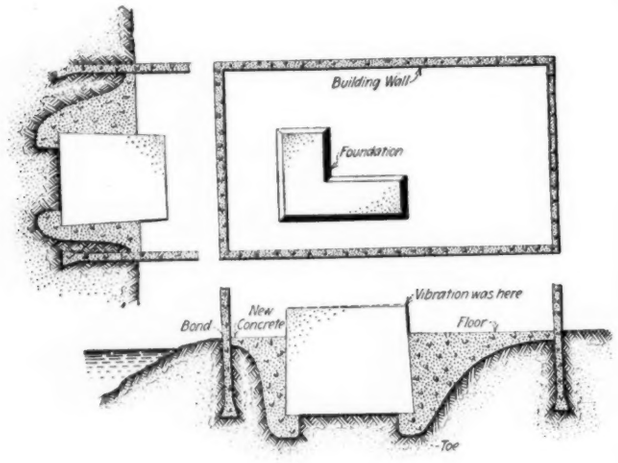
a bushing, or nozzle, in the pipe, leaving an opening only about ½ in. diameter. As long as the main valve was closed and there was no steam flowing through the cross-pipe, the pressure in both drums was the same. When the valve was opened, more steam was able to flow from the left drum than from the right because of this obstruction; but both drums were generating steam at the same rate, therefore the pressure in the right drum increased sufficiently to force the water down out of the right drum into the left one. After this core sand was removed, the trouble disappeared. Any engineer can readily imagine what would probably have happened if the boiler had been operated long under these conditions.

IRVING R. TAIT.

Montreal, Canada.

Anchoring an Engine Foundation

A short time ago I was called upon to make recommendations for reinforcing an engine and generator foundation on which was mounted a Williams 17½ x 24-in. engine, running at 200 r.p.m., connected to a 200-kv.-a. alternating-current generator. The foundation rose and fell with each stroke of the engine, the motion increasing in extent with the load on the plant. The foundation as originally constructed was satisfactory until water seepage from a pond near-by rose



ENGINE FOUNDATION REINFORCED WITH CONCRETE

around the base to within about a foot of the surface of the ground, when a slight vibration began, which rapidly became worse as the motion churned the water through the soft alluvial soil. Steam-pipe joints worked loose, bearings began to heat, and the generator clearance could not be kept uniform, so it was necessary to apply some remedy at once or the unit would be wrecked, and as auxiliary power was available the plant was shut down so as to remedy the foundation trouble.

It was decided to spread the foundation bearing surface over a much larger area and also tie it to the concrete walls of the building. This was done, as shown in the illustration by excavating below the bottom of the foundation and under its edges about two feet. Well-mixed concrete was packed in this excavation for about two feet, after which large stones were added with sufficient concrete to form a firm bond with the foundation. The surface of the old concrete was well picked and washed and the water kept out of the pit with pumps.

After the excavation was filled with concrete and large stones and allowed to set, a concrete floor was placed on top and carefully reinforced and bonded to the foundation and to the walls of the building.

The unit has been in continuous operation since this work was done and no motion or vibration of the foundation or floor is apparent, although the pond is still there and the load on the machine is heavier than ever.

D. R. SHEARER.

Johnson City, Tenn.

Publicity About Turbine Accidents

I notice in *Power* for Nov. 20, 1917, under the heading, "Publicity About Turbine Accidents," the following, signed by C. H. Camp, of Cleveland, Ohio: "Brooklyn Rapid Transit Co., Brooklyn, N. Y. Small piece of rotor jammed and broke outside case. Escaping steam fatally scalded several men."

Allow me to advise that this report is absolutely incorrect. We have never had even a minor injury to an employee, due to any form of turbine accident. In the light of the inaccuracy in this case, I would not be inclined to give much weight to the record of turbine accidents as given, and it would appear that they have been compiled without proper investigation.

H. A. ROBBINS,
Brooklyn, N. Y. Superintendent of Power.

Jot It Down in a Notebook

Many good ideas and valuable data have been lost by power-plant men on account of neglecting to record them in a notebook. Everyone has ideas and suggestions come to him frequently in the course of his daily work, while riding home, or while reading his trade paper. Or he sees another's method of doing some task, and thinks of an improvement that would prove of value, if at hand in a notebook when similar work is to be done.

Several years ago I started carrying a notebook in which to jot down all sorts of stuff—personal observations or ideas borrowed from others with whom I came in contact. I often forgot the book at first, leaving it at the plant or at home, and sometimes I had the book but no pencil, but it soon became a fixed habit. The book became so smeared with grease and dirt that I was tempted to throw it away, but the notes often proved valuable, and as the years passed, many of them were transferred from the notebook to a reference file and many have been worked out, rewritten and passed on to others.

I now carry a loose-leaf book, writing or sketching but one subject on a page, and the lose leaves are readily transferable to my file of small manila envelopes. Memory has its limitations, and one should use some means of recording valuable data. A notebook acts as a separator, skimming the cream from the milk—the best is preserved for future reference in the file. Life is full of habits, and the habit of carrying and using a notebook is one that is worth cultivating.

Concord, N. H. C. H. WILLEY.

Inquiries of General Interest

Efficiency of Steam Jet Pump—How does the efficiency of a steam siphon or jet pump compare with that of a motor-driven pump for raising water from a sump or pit? H. B. B.

The efficiency of the best form of jet pump would be only about one-third that of a motor-driven pump in good working order and properly adapted to the conditions.

Practical Test of Safety-Valve Capacity—What is the best method of determining whether the safety valve of a boiler has sufficient discharge capacity? L. B.

Make an accumulation test by shutting off all other steam-discharge outlets from the boiler and forcing the fires to the maximum. The safety-valve equipment is sufficient for operation of the boiler if it relieves the boiler of steam fast enough to prevent an accumulation of the boiler pressure in excess of 6 per cent. of the working pressure.

Rotary Converters vs. Motor-Generator Sets—What are the relative advantages of rotary converters and motor-generator sets for substations? E. C. P.

The leading advantages of rotary converters over motor-generator sets for substations are that they cost less and occupy less space than motor-generator sets. With a motor-generator set there is a better range of voltage control and less expert attendance is required, and if the voltage is under 11,000, no transformers are required; another advantage is that the motor may be used for power-factor correction.

Vacuum Load on Turbine Foundation—On the name-plate of a 7500-kw. turbo-generator set it is stated that in designing the foundation, necessary allowance should be made for vacuum load. What is the vacuum load and how is it determined? R. A. S.

The load referred to is the pressure on the foundation that is additional to the dead weight on account of the relief of exhaust pressure from vacuum of the condenser. Over the cross-sectional area of a downward exhaust passage there will be an excess of downward pressure that, per square inch of cross-sectional area, will be equal to the difference between the absolute pressure per square inch of the atmosphere and the absolute pressure per square inch in the condenser.

Rough Filtering of Pond Water—The pond from which our feed water is drawn frequently gets low and the water becomes muddy. We are considering the advisability of putting a cistern in or alongside of the pond with coke or other filtering medium and another cistern from which to draw the supply. Would such an arrangement be feasible? P. C. G.

A filter bank of coke, porous brick or gravel would be feasible as rough filtering material provided means is taken to occasionally wash the filter by a back flow of water. Otherwise the material of the filter bank would become clogged with sediment and operate slowly and imperfectly. For creating a back flow, the cisterns would need to be filled several feet higher than the level of water in the pond, using pond water, and afterward pumping out the water from the reservoir cistern until a satisfactorily filtered supply is reëstablished. In addition to thus roughly filtering the water, the quality will be improved by passing the filtered water to shallow settling tanks or cisterns in which the remaining sediment is permitted to settle out of the water before use by keeping it in a quiet condition for as long a time as practicable.

Lining for Brick Chimney—We contemplate the use of hard paving brick for building a chimney that will be 125 ft. high, with flue 54 in. diameter at the top. Would it be necessary to line the flue and how far? F. H. M.

To prevent unequal expansion of the outside shell, the chimney should be provided with a firebrick lining resting on common brick carried up within about 2 ft. of the smoke connection from the boilers and the firebrick should be extended from that height about 12 ft. higher than the connection, with the lining carried up at least 15 ft. higher in common brick.

For very best protection of the outer walls, the lining or core walls of chimneys are carried clear to the top of the chimney, but with usual chimney-gas temperatures and ordinary cold-weather temperatures, many brick chimneys with part height lining of the flues have proved serviceable. In any case the lining or core wall must have sufficient space in which to expand without coming in contact with the material of the outer walls to prevent vertical cracks or splitting of the outer walls, and also to prevent the outer wall from being raised by vertical expansion of the core wall, as that would cause cracks around the chimney.

Double-Riveted Butt- and Double-Strap Joint—What would be the efficiency of a butt- and double-strap joint, double-riveted for tensile strength of plate, 55,000 lb. per sq.in. of cross-section; thickness of plate, ⅜ in.; thickness of butt straps, ⅜ in.; pitch of rivets of the outer row, 4⅞ in.; diameter of rivets after driving, ⅞ in.? H. A.

The plate thickness of ⅜ in. = 0.375 in.; butt-strap thickness of ⅜ in. = 0.3125 in.; pitch of 4⅞ in. = 4.875 in.; ⅞ in. diameter of driven rivets = 0.875 in. diameter with cross-sectional area of (0.875 × 0.875 × 0.7854) = 0.6013 sq.in. Assuming the shearing strength of rivets in single shear = 44,000 and in double shear = 88,000 lb. per sq.in. of cross-section and the crushing strength of the material = 95,000 lb. per sq.in., then for a unit of length of joint, P in the sketch = 2⅞ in., the number of rivets in single shear = 1, number of rivets in double shear = 2, and

(A) Strength of solid plate = 4.875 × 0.375 × 55,000 = 100,547 lb.

(B) Strength of plate between rivet holes in the outer row = (4.875 — 0.875) 0.375 × 55,000 = 82,500 lb.

(C) Shearing strength of two rivets in double shear, plus the shearing strength of one rivet in single shear = (2 × 88,000 × 0.6013) + (1 × 44,000 ×0.6013) = 132,286 lb.

(D) Strength of plate between rivet holes in the second row, plus the shearing strength of one rivet in single shear in the outer row = [(4.875 — (2 × 0.875)) 0.375 × 55,000] + (1 × 44,000 × 0.6013) = 90,910 lb.

(E) Strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of one rivet in the outer row = [(4.875 — (2 × 0.875)) 0.375 × 55,000] + (0.875 × 0.3125 × 95,000) = 90,429 lb.

(F) Crushing strength of plate in front of two rivets, plus the crushing strength of butt strap in front of one rivet = (2 × 0.875 × 0.375 × 95,000) + (0.875 × 0.3125 × 95,000) = 88,320 lb.

(G) Crushing strength of plate in front of two rivets, plus the shearing strength of one rivet in single shear = (2 × 0.875 × 0.375 × 95,000) + (1 × 44,000 × 0.6013) = 88,800 lb.

The strength of the joint would depend on consideration (B), and the efficiency, or ratio of that strength to the strength of the solid plate, would be $\frac{(B)}{(A)} = \frac{82,500}{100,547}$ or 0.82 = efficiency of the joint.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

What Are We Fighting For?*

BY HONORABLE WILLIAM H. TAFT
Former President of the United States

ONE cannot come before an intelligent audience like this and fail to talk about the war. I have talked about the war a good deal in various parts of the country, and I have been impressed with the feeling that the war could be talked about a good deal more about the country, throughout the country, to the people of the country, with very great advantage. There are so many who are doubtful—they are for the Government and they are for the war, but they are walking interrogation marks as to whether we did not make a mistake here, or did not make a mistake there, or whether we are fully and rightfully in the war, that I think an evangel ought to be preached on the subject to demonstrate that we are rightfully in the war, that we never have done anything that was not justified, and that the cause now presented to us is so righteous that if we are the people we claim to be we must win it if it costs the last man and the last dollar that we have. (Prolonged applause.)

You meet men who are now, after we have decided to go into the war, and after we are in it, who are now "judicially minded"—that is to say, they do not say they are neutral, but they are judicially minded. While I am in favor of being judicially minded, I am not in favor of masquerading under a judicial mind a lack of that fine edge of loyal patriotism that we need to carry this country through the war. (Applause.) I am opposed to apathy; I am in favor of team work, and of knowing why we are in, and what we are going to do, and in favor of being determined to do it. (Applause.)

The Judicially Minded Person

You will find this judicially minded person suggest that we were unneutral during the three years that we were not in the war, because we furnished ammunition and other supplies to the Allies. Well, we had a right to do that, under international law. Germany herself had agreed to that rule of international law with respect to the power and duties of neutrals—not that neutral governments could furnish such supplies, but that neutral governments could permit their citizens to do so, the citizens taking the risk of confiscation of those articles as contraband if found upon the high seas. And there were those who sympathized with Germany after the German commercial marine had been driven from the seas, and then they said it was unneutral for us to furnish one side. The fortune of war was not our fault. The President was right in insisting that we should stand by the rule of international law in that regard, because if by our acquiescence the rule of international law were to be changed, requiring every neutral government to suppress its citizens from carrying on such a trade, it would only make overwhelming the advantages of a military nation that devoted itself, as Germany did for fifty years, to getting ready for this war, a nation which has piled up the ammunition and supplies needed to carry her through years of war. We, if subjected to a war of aggression, would never be ready. We would always be unprepared, and as a consequence, when forced into war, we would have to look about to prepare suddenly, and then find denied to us the right to get our material and supplies from the citizens of neutral nations, under the new rule suggested. Therefore, it would have been the wildest lunacy for us to consent to a change of international law in that regard, and the merits were wholly with the President in taking that position.

But, notwithstanding the fact that we pursued the path of neutrality as laid down by the law, Germany sank an English commercial liner having three thousand persons on board, and sent to their death 114 American citizens by the murderous torpedo which her submarine hurled at this vessel. Then for a year we continued a discussion, arising from Germany's unfounded claim that the vessel was armed; then she sank another vessel under similar circumstances; then we said that we would sever our relations with Germany; then she said that she would discontinue that method of warfare until further notice; then on the 31st of January last Germany notified us, as she notified the world, that she intended to resume the ruthless submarine warfare; then shortly afterward we severed our diplomatic relations with Germany; then she sank four or five American vessels returning to this country in ballast and sent to their death some twenty-five or thirty American sailors; and then we declared that a state of war existed.

Our Duty as a Government

Now, my friends, is there anything else that we could do but that? That is where your judicially minded person would come in. The answer to my question depends, first, on the proposition of what were our rights, and what were the rights of our citizens? and secondly, what was our duty as a Government with respect to those rights? International law is indefinite in certain respects, but it is as definite as the law of promissory notes with reference to the rule of the capture of commercial vessels at sea. A belligerent may capture the commercial vessel of its enemy and sink that vessel. It may capture, under certain circumstances, a neutral vessel, violating a blockade, and possibly may sink it, but an incontestible rule for a hundred years has been that that right of capture and right of destruction is subject to one limitation; namely, that the ship's company of the captured vessel shall always be put in a place of safety before the vessel is sunk.

Admiral Semmes in the Civil War sank perhaps four hundred or five hundred vessels of the United States commercial marine, but he prided himself that in all that destruction not one single human life was lost. He was an internation lawyer of repute; he was also a naval commander, and his course in that regard is the strongest evidence of what international law is on that point. Therefore, Germany violated the rights of those citizens whom she exposed to death and whom she sent to death. When a man kills another deliberately, without right, it is murder, and there is no other word nor any other term in international law that can be applied to a case where a nation kills men and women and children without right. (Applause.)

Germany's Warning of Murder

Ah, but it is said these people had notice. That distinguished and eminent Christian statesman, Count von Bernstorff, had whispered over the telephone and had intimated very enigmatically that anyone who went aboard the "Lusitania" would run the risk of being torpedoed, and it is stated that those who went down in ships sunk afterward knew that Germany was on the sea with these murderous instruments. Well, that is a fine plea. Suppose a man in New York should warn a neighbor that he could not go down into the street upon which his house abutted, because if he did he would kill him; and suppose this man who was warned was a courageous American citizen, who knew what his rights were and he went down into the street, and the threatener did kill him. Suppose that man was indicted and haled into court and called upon to plead, and he pleaded "not guilty" on the ground that he had notified this man that if he would come down into the street he would kill him, and therefore he was not guilty because the man himself was guilty of contributory negligence in running into a bullet whose presence he ought to have anticipated on the street. (Applause.)

But Senator La Follette says—(hisses on the part of some persons in the audience), oh, don't hiss, it never helps to call names, no matter how poor an opinion you have of a man, it does not help the argument—but Senator La Follette says it is true they had the right to be where they were, but those were technical rights. It is too bad when a sen-

*Address at the thirty-eighth annual meeting of the A. S. M. E., New York City, Dec. 4, 1917, on "The Nation's Call to the Professional Man."

ator in Congress, sworn to obey the Constitution, should regard the rights of those poor victims on board the "Lusitania" to life and the right to protection against the invasion of a murderous nation as a technical right.

We will now assume, therefore, that this was murder of our citizens. What was our duty? The Constitution as interpreted by the Supreme Court, indeed our general knowledge of government, would teach us that while we owe service, military and civil, to the Government, the Government owes us as a primary consideration, protection. Government is nothing but a partnership in which we are all members, and we all agree to contribute to the objects of a partnership by service; and then the partnership is to help us in enabling us to enjoy our rights. Therefore, when these citizens were actually deprived of their rights, why, it is very plain that it was the business of the Government to call for reparation in respect to those whose rights had been taken away, and security and an announcement of the policy which would prevent subsequent interference with similar rights of our citizens. Otherwise, if not, then we ought to go out of the government business, because that is the object of government.

Now, Germany announced that she not only justified what she had done, but intended to continue to murder our citizens on the high seas. Our citizens are entitled to the protection of the Government at home and on the high seas, and abroad. Abroad there is some qualification, because they voluntarily submit to another jurisdiction, but on the high seas, on an American vessel, and under an American flag, on that great road of the nations, they are just as much within the jurisdiction and within the protection of the Government at home as if they stood on the shores of New York, or Massachusetts, or New Jersey, and an invasion of their rights on the high seas by a foreign government is just as much an invasion as if Germany had landed a Uhlan regiment on our shores and shot into the homes of American citizens and killed them.

What Precipitated Our War Declaration

Therefore, if we were to continue business as a government, there was nothing else for us to do—Germany did not leave it open—except to measure swords with her in protection of those rights. If this act had been committed by Venezuela or Costa Rica, if either of those countries had sunk an American ship with a loss of one hundred lives, the President would have promptly sent a message demanding reparation and security against further invasion, and might have sent a warship down to convey the message, just by way of suggestion, and every man, woman and child, Senator La Follette, and every pacifist, would have said, "Well done." Well, now, what is the difference between that case and the one we are considering? There is not any in principle, but there is this real difference, that Germany is the greatest military power in the world, and Venezuela is not, and therefore we are very urgently and strongly in favor of the protection of the rights of American citizens when invaded by a foreign country, provided the country is little enough, but when it is a great power—the greatest military power—then the rights are "technical." (Applause.)

Oh, my friends, there was not anything for us to do except to declare war, and a pacifist or anyone else who says otherwise or intimates otherwise, does not understand. The President has set a precedent by calling them stupid, and, after such an authority, I am willing to say I agree.

Now that brought us into the war, but when we got into the war we found what possibly we ought to have known before—some did know—that the particular cause which brought us in was only a phase of the far greater cause which the Allies were engaged in fighting. We found ourselves in the beginning ranged with democracies against autocracies. I know that our judicially minded friend will suggest that England is a monarchy and so is Italy. Yes, that is true, but a democracy is a country in which the people rule, in which the policies of the government are determined by the popular will. The proof of the pudding is in the eating of it. Anyone who knows anything about England and Italy cannot say otherwise than that the people rule in these countries, and where that is the case they are democracies. Where that is the case the question of kings is only a question of taste. As a matter of fact, the King of Italy and the King of Great Britain have not any more to do in determining acute questions of the policies of their respective countries than an ex-President of the United States has. (Applause.)

Now, the President has said that we are fighting this war to make the world safe for democracy. That is a truly exact statement. But it has been misconstrued. It does not mean that we are to force democracy on other countries, that we claim to have a patent for our form of government that we are going to drive down the throats of other people. That is not what it means. It only means that the power of a people with a military and foreign policy such as that of the Imperial German Empire, is dangerous to the continued and safe existence of smaller and less powerful countries that desire to have democracies and to work out the happiness of their people through that kind of government. That is what it means.

We Must Understand German Character

We cannot understand the issues at stake without understanding the character of the German people. We cannot understand their character without following their training in the last fifty or sixty years. We all have known Germans. We have liked them. When in Germany we have enjoyed seeing them. They are a kindly people; at least they were some years ago when I visited Germany. They are a kindly people, who love their homes, they love their families, they love music and they love poetry, of which they have some of the greatest exponents in the world. They conform to authority with a kind of pleasure. They are an intellectual people, they are an earnest people, a little lacking in a sense of humor, but a great people, people capable of great effort.

The truth is, while I have a profound admiration for the English people and the history of England, because having been educated as a lawyer I believed she laid the foundations of true constitutional liberty, nevertheless I am bound to say that when I went to Europe and traveled in Europe, I would a great deal rather be closed up in a railway carriage with a German than with an Englishman; because the Englishman—I mean the regular Englishman—was constantly engaged in an affirmative effort to convince me that he did not know I was in the carriage, whereas the German was always courteous and friendly and anxious to engage in conversation.

A Glance at German History

The Germans for a long time were divided into twenty-eight different states, Austria the greatest of them, Prussia the next, and twenty-six others, and everyone who longed for an improvement in the world, and an improvement among the Germans, wished for unity among them. There were liberty-loving Germans, and in '48 they rebelled against the Divine Right of Kings, and they had revolutions. They were not successful. They did get a constitutional monarchy for a little while in Prussia, and offered the crown to Frederick William, the great-uncle of the present emperor, and he said he would not take it, because he got it from God, and did not purpose to take it back again out of the mud, showing that the Divine Right of Kings came honestly down that line to its present exponent.

A large number of these liberty-loving Germans were driven out of Germany and came to this country, and made one of the most valuable elements of our citizenship here (applause), and when the Civil War came on, loving liberty as they did and hating slavery, they went into the war, enlisted in great numbers, and on every battlefield in that war the blood of our German citizens was shed.

Their descendants and others who have come here since have continued to make a valuable part of our citizenship, and during these three years when we were neutral they have naturally, because of the pride in the success and prosperity of their brethren at home, had a sympathy with Germany and listened to the arguments in her behalf which have been put forth in this war. And now the war between

America and Germany has come on, and their allegiance requires them to be loyal, and they are put in a sad position, and one in respect to which we should be considerate of them. But they are loyal, they have enlisted, they have gone into the draft, and contributed to the great patriotic funds; and while they are not vociferous—we could hardly expect them to be so—that they are going to be loyal I have not the slightest doubt (applause), and one of the things we ought to be most thankful for is that very thing. The reason why Germany treated us as she did was because she counted on dissension among our people, growing out of the disloyalty of that very element, and she has been disappointed in that regard as she has been disappointed in so many of those instances where she has attempted to read the motives of other people.

Prince von Bismarck's Policies

Instead of founding a constitutional monarchy, with representative institutions, and bringing about unity, as those leaders of German thought, Carl Schurz and others hoped for, there came into the history of Germany a very different individual, Prince von Bismarck, who was the Premier of Prussia in 1862. His theory was that he would conquer and unite the German nation by blood and iron, and he developed the army, always a well-controlled body in Prussia, and he made the nation into an army, and an army into the nation, and then he planned the wars upon which he founded the unity of Germany. He became involved in a quarrel with Denmark, and induced Austria to go in with him, and took away Schleswig-Holstein from Denmark; and then when he got it, he found it was so easy that he annexed it forcibly to Prussia; and when Austria asked, in a diplomatic way, just what there had been in that war for her, he said there was not anything. And then he got into war with Austria, as he had intended, and in six weeks he wiped her off the map of Germany. Then in that war he annexed forcibly Hanover and Frankfort, and made an offensive and defensive alliance with Württemberg, and Baden, and several other German countries; and then he sat down to wait until that fakir, Napoleon III, in his pirouetting, would bring about an appearance of a war of aggression against Germany, which was exactly what Bismarck was waiting for, and he only had to wait four years for that; and if you will read his memoirs you will see how he brought that about. You will be interested in reading, I am sure, that interview between himself and von Roon and von Moltke. They received a telegram from the Emperor outlining an interview between him and Beneditti, Napoleon's ambassador, and they were thrown into gloom, because the interview was one which seemed so pacific to them that they thought its publication would prevent war; and Bismarck sat down and, without changing the body of the message, changed a few words in it and published it; and then von Moltke said, "Now we will have war." He said, "That telegram, when it came, sounded like a parley. As you have changed it, it sounds like the rattle of a drum." This was stated by Bismarck himself. So, true to his plan, Napoleon declared war, and then, in a short time, Bismarck defeated France and took Alsace-Lorraine and an indemnity of a billion dollars, which the Germans put into the army, and Bismarck crowned a Prussian King Emperor of Germany at Versailles, and he went back to Berlin and sat down as the head of the empire to digest the pieces of territory he had bitten off in the last three wars.

The Seeds of Kultur

He was not in favor of world domain. He wanted to raise Germany to a great power in Europe, and he succeeded. He made fun of the ideal of world dominion, but there was held out to the German people the idea that all the rest of the world would try to get back from them this territory which had been taken, and therefore they must defend themselves, and so they went on and provided greater and greater armies.

They also adopted in their wonderful way, as you gentlemen of science know, the principles of science to the manufacture of everything, and to every field of industry and business. They introduced a system which they called Kultur, and which brought about a prosperity in competition with the world that attracted the admiration of the world. Their population increased and pressed upon their borders, and with their marvelous successes in the three wars, with their wonderful administration and the demonstration of their efficiency in their prosperity, and with their increase of population, they acquired megalomania, and they learned to think that they were supermen. They believed they had invented Kultur, and it was their duty to spread it over the world and enlarge their borders and conquer the world for the purpose of spreading that Kultur.

And they soon, by reason of their elevation as a people, associated themselves with God. They regarded themselves as the agents of God. They are a people of an inexorable logic. If they begin with a false premise, as they often do, their confidence in logic is such that they wipe out any fact that is inconsistent with the conclusion reached by that logic. You remember the story of the old German who was in the California gold diggings and met a man out there whom he had seen only recently in New York; and anxious to find out how he had gotten there, he asked: "You came the plains across?" The man replied, "No." "Then you have come the Isthmus over?" "No." "Oh, then you come the Straits of Magellan through?" "No." "Oh, I see, you were seasick coming the Horn around?" The man replied, "No," and then the German's eyes opened and he looked at the man for a minute and he said: "Well, then, you have not arrived!" (Laughter and applause.)

Having established that Kultur was necessary for the world, and that they had invented it, they believed that they were the people to spread it; and then, with that inexorable logic, all of these other conclusions followed. The state, the German state, was to spread Kultur. It was to do God's work. Therefore, every consideration must yield to the doing of that work. The state was above everything. The state, engaged in this work, could do no wrong. Therefore, these considerations of honor and decency and the performance of obligation, could play no part. International morality was eliminated. The only sin of a state was weakness; its virtue was power. And that doctrine, or its elements, the idea that Germany was over all, was preached in the schools, in the academies, in the universities, by the great lecturers, by the military writers; and the conviction grew with the people, first, that they must protect and defend themselves and give everything to the army necessary to accomplish that, and, secondly, that they must base their state on force and maintain that force in order that they should spread Kultur to the world by domination and conquest. They eliminated, as I say, international morality.

Obsessed as with Insanity

Now, that is the nation and that is the people that we are engaged in fighting. They are obsessed as with insanity, otherwise you cannot explain what you see and read and know. "Why is it," you ask, "we did not know this before we got into the war?" Well, we read excerpts from the lectures and military writings, but we have cranks of our own—I need not mention them—but certainly we do not want to be held responsible for their writings and their statements and their actions, and we assumed that these people, thus speaking among the Germans, belonged to that necessary and conspicuous, but we hope with us unimportant, element. But it was not so in the case of Germany, and you can read now the books that have been prepared impartially showing these sermons and lectures, and showing that these lectures spoke for all the people. Consider, for a moment, that there was a writer who in one of his writings incorporated a prayer like this: "Oh, Thou, who presides over all, up above, high in the skies, up above the Cherubim and Seraphim—and the Zeppelins—"

Now, that association, if it did not shock your feelings as irreverent, would suggest a humorous view; but to the German mind, with the idea of what the Zeppelin was to do in spreading Kultur, it was the agency of God; the association between the cherubim and seraphim, which are supposed to be God's agents, with the Zeppelins, was entirely proper. They preached sermons on the German God.

It is the people of Germany we are fighting, with the characteristic they have of subordination to the authority of the Prussian military regime and the Kaiser, and we must not assume they are compelled against their will to do this fighting. They have made too many heroic sacrifices in loyalty to this false idea, and in loyalty to the leadership of the Kaiser, and therefore what the President says must not be misconstrued. What we are trying to do is to separate the people of Germany from the rulers of Germany, but the only way we can separate them from their rulers is by hitting them on the head with a club so that the psychology of the situation will be brought home to them. (Great and prolonged applause.)

If you look for proof of this position of Germany with reference to the abolition of international morality you can find it in their method of warfare. I do not think it necessary to go into a detail recital of the awful atrocities that have been proven before you can arrive at a general conclusion as to their violation of every rule of warfare. They bombarded unfortified towns, an act which is forbidden by international law, and the men who bombarded these unfortified towns on the east coast of England were rewarded by being decorated with the Iron Cross.

The Hague Conference provided certain rules with respect to the carrying on of war by means of aircraft, one of which was that belligerents were not to drop explosives from aircrafts on undefended towns; and the Germans promptly sent their Zeppelins, that were assembled for the purpose of carrying on war, and to which they turned for the purpose of carrying on the war, and they sent these Zeppelins to England and slaughtered innocent noncombatants. Of the thousands of victims of the Zeppelin raids, possibly not more than fifty soldiers and sailors were hit, and only one or two arsenals, but the great body of the victims is composed of women and children, and old men. The men who navigated the Zeppelins in these air raids were also rewarded with Iron Crosses.

Kultur's Path in Belgium and Armenia

When the Germans entered Belgium they violated their treaties through which they had given their plighted faith for sixty years with the other nations. You would think, when they went into Belgium, under these circumstances, they would treat the people with some consideration, even in spite of their obsession. Did they? No. What they did was to take a district in Belgium and direct their soldiers to pursue the policy of "Schrecklichkeit"; that is, to stand up against a wall the leading citizens and shoot them, as well as the women and children. You ask for proof? Well, read the report of Lord Bryce. He is a lawyer, an able lawyer, and an historian, and he was on the committee with other lawyers and judges, and they took the evidence and dissected it and analyzed it. They rejected all the evidence as to the sporadic brutalities by soldiery which you encounter in every war, and took only the evidence of cases that could not have been committed except by the order of officers, and they showed that this was part of the military policy of Germany in terrorizing the rest of the innocent Belgians by such cruel atrocities in respect to the families of this particular little district.

But the worst thing they have done has been with respect to Armenia. When England brought over the Indian troops to help that small regular army of hers, and they came and made good soldiers, showing they had been well treated, the Germans held up their hands in holy horror and said, "They are sending Mohammedans to fight Christians," all the time having that eminently Christian Monarch, the Sultan of Turkey, in alliance with them. And after the alliance was secure, then Turkey proceeded to carry out a purpose that she had partially attempted to carry out years before in ridding herself of Armenian Christians in her empire. She proceeded, with Germany looking on, and with officers of the German army at hand, through her regular soldiery and her irregular soldiery, to murder 800,000 Armenians because they were Christians. Now that is an evidence of the false philosophy, the horrid philosophy, that there is no international morality, and that nothing should stand in the way of military success and the advance of the state in the spread of Kultur.

That is the kind of enemy we have to fight. That is the psychological state of the German people, and the only way in which we can change it, as I say, is by defeating them. If we defeat them, then they will appreciate the falseness of a philosophy which can be justified only by victory, and then when they are defeated, as we must defeat them, then they will relegate the Kaiser—it will not need any action on our part—they will relegate the Kaiser and the Prussian military regime to the place where they ought to go. (Applause.)

Their Sin Has Found Them Out

It is a very satisfactory thing to see that the sin of the Germans in this regard has found them out. When the war began, good Christians hesitated about believing in a good God, when they saw that so many innocent men could be hurled into a vortex of destruction, agony, suffering and death like this. Now the thing is cleared away, and what we see is that the world has been suffering from a cancer of militarism, and Germany has been responsible for it, and she has led the world on to these great armies, and on her hands is the blood of this awful war—this war with fifteen or twenty times the number of men engaged in it, and with an equally increased amount of suffering and agony, compared with any other war—with 40,000,000 men engaged, 7,000,000 men dead, 6,000,000 men in the hospitals, and 6,000,000 men in prison camps. That is due to Germany. The cancer cannot be cut out but by suffering. God works by inexorable laws and the penality of sin must be paid.

This is a German war of aggression as any schoolboy can now see. The White Paper did not show any communications between Germany and Austria during that anxious time, and they have never been disclosed, but we know now that Russia was not prepared, and England not any more prepared than we are today, and France was very lacking in her preparation, and yet we are to believe that these three countries conspired to attack Germany who was ready to the last cannon and the last reservist. Why, that is enough to make a horse laugh. It is true that Germany did not advise the killing of the crown prince and his consort. That is not the way Germany has begun her wars. She gets ready. She plans a war. She gets ready, and then she waits for the opportunity so that it shall seem to be a war of aggression by other powers. That is true in every war she has waged since Prussia has been in power.

Germany's Woeful Blunders

So to go back to this sin of Germany finding her out. She has been perfect in military preparation; she has been perfect in military strategy, but where has she made her blunders? She has made her blunders, and her great blunders, in misreading other peoples, in her diplomacy, and she has made these blunders because she has eliminated from her own soul considerations of morality and motives of good, motives of service and allegiance and unselfishness, and therefore she has eliminated those from her judgment when she goes to judge of what other people will do, and so she made a mistake about Great Britain, and her conscience in respect to Belgium. She made a mistake as to the British possessions—I mean those independent dominions—she said, "The tie which binds the dominions to the mother country is very light. There is no reason why they should go in, there is nothing in it for them," and she was indignant and exasperated when she found that her judgment in that regard was wrong. That is because she could not appreciate the filial relation between those countries and Great Britain. She could not appreciate the daughter's loyalty to her mother that had protected her. Is there anything more noble in this world war than the way in which Canada and Australia have responded to the call of the mother country? Canada has sent 420,000 men, and Australia 400,000 men, Australia having a population of five millions and Canada six or seven millions. In proportion, we would have to send an army of seven millions. And then France. Germany said France was decadent, permeated with socialism, no patriotism, and deeply affected

with frivolity. France was not prepared, but she rallied her legions, and is it not inspiring to think of the fight that she made, knowing that the German military s... was attempting to crush France first, and she stood up, and with that thin line of the British regular army, she hurled back the German hordes at the Marne and saved the world? (Great applause.)

The biggest mistake she has made has been with respect to this country. I remember some of the things the papers said—they said we were a tangoing nation. They said we were too fat to go into the trenches. They had a contempt for us because we had not prepared for war. They assumed our citizens of German origin would prevent the war, and political considerations would divide the people in that regard. They were also obsessed with the idea that they could end the war with this murderous weapon, this weapon they could not use except by accompanying its use with the murder of neutral people. So they went in.

Now, ten, fifteen or twenty years hence, when our grandchildren go to their fathers, after having read a history of this war, they will say, "Papa, why in the name of common sense did Germany force the United States into this war?" And papa will have a hard time to tell, unless he goes into all of the circumstances and treats the subject from a psychological standpoint, because the boy will say—any child would say—"Why they had been fighting this war for three years, exhausting as no other war has been before, so that they were all not exhausted, but nearly so, and at that time they deliberately forced into the war against them that gigantic young nation that could furnish what is absolutely necessary, and what must determine victory in the war, more food, more money, more fighting men than any nation in the world."

Seven Million Men for America's Army

Now, that is what they have done, and nothing can explain it except the obsession that I have referred to—their failure to see things in other people, because they have eliminated from their own consideration those moral motives. Now what are we going to do about it? I have said, potentially we are the greatest power in the world. We are a potential military power, and we have got to make that thing which is potential actual, and that is no mean job. We have before us a war of two, three or four years. We have got to raise an army of five million or seven million, or possibly more. It is man-power that is going to win this war. Russia has become a pulpy mass, and it has got to work out its own salvation. There is one feature about that situation, and that is that the Germans will not know any more about what is going to happen in Russia than we do, but it is going to enable the Germans to bring back, doubtless, many of her divisions to the Western front; and we must fight the war out on the Western front, and it may be that the Western front will reach from the North Sea to the Adriatic. We have got to furnish to our Allies not only food, not only money, but we have got to furnish them the man-power that will give a predominance that will win this war. We have got to wear them out, it may be by attrition, as Grant wore Lee out, but we have got to do it, because civilization depends upon it, because our own independence depends upon it. The war is not in our souls yet, not as it will be when our boys are shot down and when we consult the casualty lists to see whether those dear to us have suffered. One of the great satisfactions is that when we are in it, when we meet disaster, as we are going to meet disaster, and we find there have been blunders, as there will be blunders—but from these blunders and from these disasters the American people are so constituted, with their inherited traits, that those disasters and blunders and defeats and humiliations will only make us stronger to carry out the struggle that is essential to liberty and Christian civilization. (Loud applause.)

The *Engineer* (London) credits J. F. Crawley with the statement that only 5 per cent. of the machinery in the textile industry in England is electrically driven by current generated on the premises and 0.5 per cent. taken from central stations.

Men Wanted for Aviation Branch U. S. Navy

For the further extension of the aviation branch of the United States Navy, Secretary Daniels has authorized the enlistment of 8000 young men, and in doing so has opened up most attractive opportunities in this new and unusually appealing service. There is an important and immediate need for mechanicians for naval aviation for the ratings of machinists' mates, carpenters' mates, quartermasters, coppersmiths and blacksmiths. These men will not be enlisted for pilot's duties, but coming into the service with a general mechanical turn and a liking for the work, they will receive a special and unusual training for the building, handling, repairing and overhauling of the Navy's air craft. Succeeding in this, they will be used as the ground personnel of the flying corps.

The requirements for enrollment will be the same as those for the regular service of the United States Navy. Training for machinists' mates and quartermasters will last about three months. Carpenters' mates will train for approximately six weeks. On completion of training course the provisional landsmen, after examination, will be rated first- or second-class petty officers on the basis of examination and all-around ability. After getting a rating, they will be eligible for promotion to the next higher grade if they show fitness and pass the necessary examination. Promotion in the aviation field is unusually fast. The age limit for this enlistment is 21 to 35 years, and each candidate will receive the United States Navy physical examination and not that required for flight duties. Men enlisting for aviation duty but failing to qualify will, if recommended by their commanding officers, be assigned to general service.

The following trades are covered by the ratings: Carpenters, woodworkers, machinists, coppersmiths, blacksmiths, fabric workers, riggers, acetylene welders, gas-engine overhaul men and instrument makers. Requirements for the various classes of landsmen to be enlisted are:

Landsman for quartermaster; although no previous trade experience is required, a general manual ability is called for Men of trades such as rigging, fabric working and wire working are desired, as are also men experienced in the operation of hydrogen plants or in the care and upkeep of dirigibles or ballooons. Men in this training who display proficiency on dirigible work will be assigned to this branch. These men will also be used as seaplane riggers, for general structure and overhauling and also inspection of dirigibles preliminary to flight.

Carpenters' mates will look after the upkeep and repair of wings, pontoons, flying-boat hulls and bodies, balloons and dirigibles, their training covering the practical application of their trade skill and general aviation work.

Machinists' mates will show previous experience in gasoline engines or any allied skilled trade such as that of electrician. These will be charged with the upkeep and overhaul of aircraft engines. Their training covers a practical understanding of aircraft engines.

Provision is made for men especially well qualified for enlistment or enrollment as carpenters' and machinists' mates to be enrolled directly for that second-class rate should their skill be sufficient. The rating badge for men in this service will be the same as the regular except for the addition of double wings.

Quotas for enlistments for the various districts have been arranged as follows:

Eastern Division—Machinists' mates, 900; quartermasters, 900; carpenters' mates, 390; blacksmiths, 30; coppersmiths, 40. To transfer to Naval Air Station, Bay Shore, Long Island.

Central Division—Machinists' mates, 900; quartermasters, 900; carpenters' mates, 390; blacksmiths, 30; coppersmiths, 40. First three classes to transfer to Naval Training Station, Great Lakes, Ill., and for further transfer to Dunwoody. Coppersmiths and blacksmiths to Naval Air Station, Bay Shore, Long Island.

Southern Division—Machinists' mates, 500; quartermasters, 500; carpenters' mates, 200; blacksmiths, 20; copper-

smiths, 20. First three classes to transfer to Naval Aëronautic Station, Pensacola, Fla.; latter two to Naval Air Station, Bay Shore, Long Island.

Western Division—Machinists' mates, 700; quartermasters, 700; carpenters' mates, 320; blacksmiths, 20; coppersmiths, 40. First three classes to transfer to Naval Air Station, San Diego, Calif.; latter two to Naval Air Station, Bay Shore, Long Island.

Producing Synthetic Gasoline by Electrochemical Means*

By L. B. Cherry

It is well known that most of the crude-oil distilates and natural gases of the United States are of the paraffin series of hydrocarbons and that natural gas is composed largely of methane, which occupies a place at the beginning of the series and is the simplest of the group; while going toward the more complicated molecular structures, we find about 60 well-defined, saturated, normal hydrocarbons, terminating with the solid hexacontane, with a melting point of 101 deg. Centigrade.

Our commercial gasoline occupies a place in the series a little above those which are normally gas, and is composed of a probable blend of hexane, heptane and octane, for a good grade of gasoline, although we are tempted to believe that some grades on the market today contain hydrocarbons of much higher boiling points.

The aforementioned hydrocarbons are called paraffins because they resist at low temperatures the action of most reagents, and are in fact compounds, with an almost indifferent character, refusing to take on more hydrogen or even to chemically unite with any of their associates.

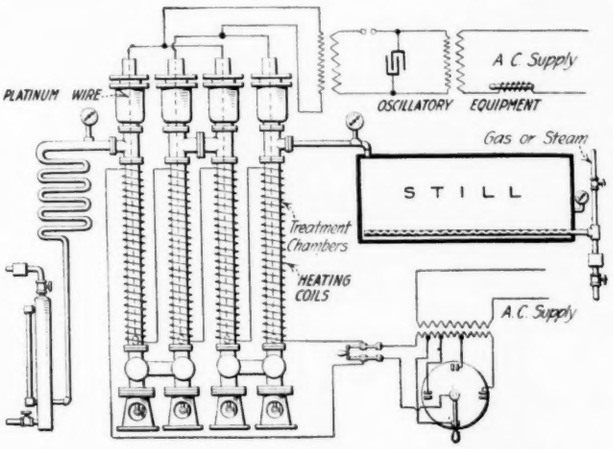
If we could chemically unite, in proper proportion and form, sufficient methane, or hydrogen gas, to certain of the heavier hydrocarbons, we could produce synthetic gasoline. The small increase in percentage of hydrogen necessary to convert some of the heavier fractions of crude oil into the lighter and lower boiling-point compounds is surprisingly small. The first experiments along this line were conducted with a small laboratory equipment, the still being composed of a piece of 3-in. pipe, the ends of which were closed with caps, threaded and screwed on. The treatment chambers, wherein the gas and oil vapors were subjected to high-voltage oscillatory, high-frequency current, were made of 1-in. pipe which had been plugged and reamed, the ends of which were fitted with modified spark plugs which served to lead the current through a fine No. 30 platinum wire. This wire passed through the center of the pipe from end to end and, when connected to the high-frequency coil, subjected the gas and oil vapor passing through the pipe to a silent electric discharge alternating back and forth between the central electrode and the pipe wall, and at a right angle to the direction of the flow of gas.

This first equipment was very crude, without pyrometers or pressure gages, and was operated at high pressures and high temperatures, but it served to demonstrate the feasibility of the process by converting 42.5-deg. B. kerosene into 65-deg. B. gravity gasoline. As already stated, this was done at high pressures and temperatures, and was operated for several hours before the experiment exploded, completely wrecking the small frame building in which it was located. Later experiments with larger and better equipment proved that a very high frequency was necessary to obtain low boiling-point compound and that increasing the frequency would raise the specific gravity (B.) and lower the boiling point.

The still of this equipment was of 4-in. double-extra-heavy pipe construction, with welded flanges, electrically heated, and consumed about 40 kv.-a. at 60 volts, using 60-cycle alternating current. The oscillatory electrical generating apparatus for this plant consisted of 1 kv.-a., 110- to 25,000-volts step-up transformer with a variable reactance in the primary, and a variable condenser, rotary spark gap and oscillatory transformer. An equipment of this type is shown in the figure.

The difficulties encountered with operation under high pressures were so great that it was decided to carry on experiments under atmospheric pressure, in which it was found that as good products could be obtained as when operating under higher pressure, but the percentage of conversion was not so great, and the gravity was not quite so high, 33 per cent. of the kerosene being converted to an average density of 54 deg. B. (specific gravity 0.761) and by rerunning the residue, which was practically the same density as the original kerosene, it was discovered that an additional conversion of 33 per cent. was obtained for every time fractionation was made, and the remaining residue run through the still.

At the conclusion of these experiments it was decided to build a larger plant and incorporate in its design the benefit



DIAGRAMMATIC LAYOUT OF FRACTIONATION EQUIPMENT

of the experience with the older ones. The step-up transformer was designed for 110-220 to 50,000-100,000 volts, and rated at 30 kv.-a., but with a real capacity of 75 kv.-a.

In this plant the high-frequency equipment is capable of producing high-frequency current from 15,000 to 250,000 volts and has a capacity of converting into gasoline about 60,000 gal. of oil in one day of 24 hours.

Experiments with the first plant, with its 3-ft. treatment chambers, proved that they were not sufficiently long, so when building the second plant the treatment chambers were built with a total length of 10 ft. For experimental purposes a 7-bbl. still is used, which is fired with natural gas, and the vapor outlet of the still is connected to the treatment chambers. These pipes are heated by induction, being wound their entire length, as shown in the figure, with 00 copper cable, electrically insulated with a special fireproof insulating compound. On operating this equipment a 78-per cent. conversion was made from kerosene, and as this was not considered ideal, it was decided to increase the length of the treatment chambers to 34 ft., which should give an efficiency approaching 100 per cent. conversion. At the time of preparing this paper this new treatment chamber equipment could not be operated on account of delay in the delivery of substation apparatus which is to furnish power.

The possibilities of this process are apparently very great, for by converting the distillate between the benzine fraction and that part in which the lubricating oils are found, it is possible to increase the output of gasoline 200 per cent.

One kilowatt of electrical energy used in the treating chamber will convert 1000 gal. of distillate in 24 hours, or a 60-kw. plant should convert about 60,000 gal. per day. A total of 1440 kw.-hr. is required for the oscillatory current to treat 60,000 gal. It has been found by experiment that approximately 40 kw.-hr. of electrical energy are required for heating the treatment chambers while producing 60 gal.

*Abstract from a paper presented at the Thirty-second General Meeting of the Electrochemical Society, held at Pittsburgh, Oct. 3 to 6, 1917.

per hour, and if the ratio holds true for a 60,000-gal. plant, it would take 39,360 kw.-hr. for heating the treatment chambers while 60,000 gal. was being converted; this added to 1440 kw.-hr. would make 40,800 kw.-hr. total energy required, which, at 0.6c. per kw.-hr., at which price electric energy can easily be produced at refineries, would make a total of $244.80, or about 0.4c. per gallon.

Enlisted Ordnance Corps, U. S. Army

The Ordnance Department of the United States Army is building somewhere well behind the lines in France a depot for the salvage and repair of army supplies. Shops and warehouses covering a hundred acres are under construction upon land leased by the Government. No original manufacturing will be undertaken, but everything will be repaired from a buckle to a motor truck and from a revolver to a large gun. The repair of airplanes is not included, however, this department having its own shops. The repair of garments, etc., is also taken care of by the Quartermaster Department, which again is outside of the project under review. Sensational stories to the effect that the depot was to cost one hundred million on which the contractors were to collect 10 per cent. are swept aside by the assertion of the department that the cost will not exceed one-fourth or one-fifth of that amount, and that the job is being handled by the Stone & Webster Engineering Corporation at 3½ per cent. up to a certain expenditure and 3 per cent. on any excess, with a maximum limit.

It will be seen that this depot will involve a personnel equivalent to a small town, several thousand employees being required. Arrangements will be made for one or more sources of power supply from central stations.

The Ordnance Department in the field needs skilled men in almost every line of trade. Military training is not absolutely essential, and those enlisting will, as far as practicable, continue the type of work they followed in civil life, thus making use of the experience and skill gained in times of peace. The skilled man who makes the sacrifice in pay to become a noncommissioned officer or enlisted man in the Ordnance Corps will have the satisfaction now and later of doing the work for which he is best fitted, for the Government—work that is fully as important to the success of the war as fighting in the trenches.

Among those artisans especially needed at this time may be mentioned auto-truck drivers, auto-repair men, armature winders, autogenous welders, assemblers (shell and case), automatic-screw machine operators, blacksmiths, boilermakers, brick and tile men, brass melters, carpenters, coremakers, cupola tenders, draftsmen, drop-forgers, dynamo tenders, electric welders, electricians, firemen, gunmakers, grinders (tubes, tools, etc.), hydraulic-press operators, horseshoers, harnessmakers, boiler inspectors, locomotive engineers, locksmiths, laborers, machinists, mill foremen, millwrights, machine woodworkers, molders, polishers, patternmakers, painters, punch-press operators, plumbers, solderers, sheet-metal workers, steamfitters, stationary engineers, toolmakers, vulcanizers, wheelwrights, masons.

Applicants must be between 18 and 40 years, citizens or declarants; must be able to speak, read and write the English language; should have no absolute dependents; and must be able to pass a physical examination conforming to that prescribed for the Regular Army.

Pay ranges from $30 to $61.20 per month, depending on demonstrated ability and place of service. Men proficient in the trades mentioned, if found qualified at place of service, may attain the rank of ordnance sergeant, sergeant first class, or corporal. In addition to the regular pay, free quarters, rations, clothing, bedding, medical and dental attention are provided by the Government.

Secure an application blank at the nearest recruiting office or by writing to the War Department, Office of the Chief of Ordnance, Enlisted Personnel Division, Washington, D. C. Fill out the application blank as directed, return it, and if there is an opening suiting your qualifications, authorization will be sent you to enlist at the nearest army recruiting station, and if accepted there, free transportation will be provided to place of service.

Performance of a Steam-Driven Raw-Water Ice Manufacturing Plant*

By Van Rensselaer H. Greene†

The plant in question was installed last summer at Chester, Penn., as a 70-ton raw-water can ice-making plant based upon sixteen 300-lb. cans to the ton, and 220 ft. of 1¼-in. ammonia pipe in the brine tank.

Referring to last year's paper[1] before this association, it was pointed out that it is not possible to produce an economy of 20 tons of ice to the ton of coal unless the plant is designed to maintain a suction pressure of 25 lb., a condenser pressure not in excess of 165 lb. and an auxiliary load for pumping air, water and other equipment in excess of 50 hp.; and that to accomplish this result, even on this basis, the steam rate of the prime mover cannot exceed 11.9 lb. of steam per indicated horsepower.

In the construction of this plant it was advisable to purchase equipment which would fulfill the requirements set forth above from various manufacturers who would be willing to guarantee economies that would result from the use of their equipment under prescribed conditions. Taking into consideration first cost and relative economy guarantees, it was decided to install a uniflow engine which should be direct-connected to a high-speed ammonia compressor. With the ammonia-compressor equipment were purchased twelve atmospheric ammonia condensers arranged with drip connections so that the liquid ammonia may be drawn from condensers as fast as it is condensed. These condensers were bought with the specific guarantee that with a load equivalent to the manufacture of 70 tons of ice per day, the head pressure would not exceed 165 lb. condenser pressure when 350 gal. of 80-deg. F. water was showered over them.

Taking into consideration simplicity and economy, it seemed advisable to operate a lineshaft from a pulley located alongside the uniflow engine. From this lineshaft were driven the air compressor which furnishes compressed air for agitating the water in the ice cans, and an electrical generator, which in turn supplies current for the lights, motor-driven centrifugal water pump, cranes on the ice tank and miscellaneous equipment.

It is estimated that the peak summer load on this plant to manufacture 70 tons of ice and take care of the auxiliaries would not exceed 210 i.hp. Bearing in mind that the economies of a uniflow engine consistently increase as the load falls off, barring engine friction, it seemed advisable to install a 250-hp. uniflow engine. Such an engine was purchased with a guarantee that it would deliver the required 210 hp. with a boiler pressure of 165 lb., superheat of 150 deg. F. and a vacuum of 25 in. for a steam consumption of 11½ lb. The exhaust from this engine was connected to a barometric steam condenser, which in turn was guaranteed to condense all the steam consumed by the engine and to maintain a vacuum of 25 in. on the exhaust line when 400 gal. of 90-deg. water was passed through it.

The boiler equipment for this plant consisted of two 200-hp. water-tube boilers with superheaters, with hand (Huber) stokers. These stokers were guaranteed to evaporate 9¼ lb. of water per pound of 14,000-B.t.u. coal, provided the water entered the boiler at 212 deg. F. Theoretically, then, without losses we should have been able to manufacture 70 tons of ice per day for approximately three tons of coal, or 23½ tons of ice to the ton of coal.

Delays incidental to a likelihood of the property being condemned by the Pennsylvania Railroad Co. delayed the purchase of the equipment to a date that made it impossible to put the plant into operation before the middle of July.

Probably no other city has suffered a greater inconvenience from the labor standpoint than has Chester, brought about by the close proximity of the Baldwin Locomotive Works, the new plant of the Sun Shipbuilding Co. and many other industries more or less allied directly with the Gov-

---

*Paper before Eastern Ice Association, Atlantic City, November, 1917.

†Consulting engineer, 50 Church St., New York City.

[1]"Limitations of Steam-Driven Raw-Water Ice Plants."

ernment in prosecuting war orders; and for this reason it was not an uncommon thing to find a new crew of men in charge of the tankroom at the Chester ice plant daily. This condition made the testing of the plant during the summer weather a most difficult one, and so no accurate figures were obtained on the operation until the middle of September, when a test was run to determine how near these guarantees were actually fulfilled in practice.

This test was made, not with the hope of furnishing any check on the actual performance of the ice-making end of the equipment. because you all realize that an ice test in September cannot be relied upon; but as near as possible, summer conditions were created by the shutting off of the water-supply over the ammonia condensers to create a summer head pressure, and the throttling of the water through the steam condensers to create the desired vacuum.

The plant was actually operated enough during the summer months to produce an average of 70 tons of ice per day, while at the same time the daily-ice storage house, having a capacity for 300 tons of ice, was maintained at a temperature of 28 deg. F. Indicator cards from the compressor for determining the correct valve setting were taken on Aug. 10. This day the head pressure was 155 lb., while the back pressure was 25 lb., and from the information secured from the chief engineer it is safe to state that the guarantees of 165 lb. condenser pressure were met.

Ignoring, then, the question of the quantity of ice actually made in this test during September, we do know that the conditions, as called for, were artificially maintained, and therefore the consumptions of the ammonia compressor, auxiliaries and the water rate of the steam engine, as well as the efficiency of the boilers, should be fairly accurately determined.

During this test the cold-water supply to the feed-water heater was weighed by means of weighing tanks, while the condensate from the feed-water heater was weighed, as well as the quantity of steam consumed in the thaw needle and in the dip tank of the ice plant. The difference between the weighed water-supply to the boiler and these three items was taken as the steam consumption of the uniflow engine. It was mutually agreed that a discrepancy of 10 per cent. should be allowed as representing losses in general throughout the plant, such as condensation in the steam pipes, leaky valves and miscellaneous other losses which are always to be found around a plant of this character.

The actual water fed into the boiler during a run of 10 hours was 3420 lb. per hr., of which 414 lb. was condensed in the feed-water heater and 282 lb. was condensed in the thawing tank and thaw needle. The difference between the sum of these two items and the total quantity weighed into the boiler is 2724 lb., which, divided by 210, the indicated horsepower of the steam cylinder, gives a water rate of 13 lb. Taking off 10 per cent. from 13 lb. as the agreed discrepancy, there was an actual water rate of 11.7, as against the 11.5 as guaranteed.

In the writer's opinion, it is fair to assume that the economies of the engine under the stipulated conditions were even better than the guarantees, based upon the fact that during the test run the superheat fluctuated considerably and averaged over the whole period of the test approximately 100 deg., as against the 150 deg. originally specified.

So far as the general efficiency of the boiler and stoker was concerned, an average of 370 lb. of coal per hour was actually burned under the boiler, with the feed water entering it at 210 deg. F. The boiler evaporation was 9.56 to 1 and the production of ice per ton of coal was 19 : 1, based on the manufacture of 70 tons of ice per day, plus four tons which I have charged against the load of the daily-ice storage room.

The boiler setting at this plant is unusually high and is built along the lines talked of by the writer at the recent meeting of the Eastern Ice Association, held at Richmond, Va. The height from the floor to the bottom of the first row of tubes is 7 ft. The over-all boiler efficiency developed during this test averaged 72.6 per cent. The coal burned was the average coal received this year and, in accordance with the general views of the management of the company, was not up to the usual standard received during other years. Unfortunately, the analysis of the coal has not been received up to the present time, but in all probability the coal had a heat value in the neighborhood of 14,000 B.t.u. per pound.

It is not the intention of this report to show what can be accomplished by any one specific type of machine, since there are many engines, compressors and general equipment on the market which should produce the economies obtained by this plant, but the paper shows how it is possible to procure definite plant economies under direct guarantees from manufacturers that will bring about a certain predetermined result; and to further show that in this particular plant, before the over-all economies could be obtained, it was necessary to get a guarantee of horsepower from the ice-machine company, a guarantee of steam economy for this horsepower from the engine company and a guarantee of coal economies from the stoker company, stating under exactly what conditions they would be willing to generate the amount of steam that was required by the engine builder in order to arrive at a definite quantity of coal burned.

This should show how unfair it is to ask from any ice-machine manufacturing company an over-all guarantee involving the backing up of equipment which they themselves do not manufacture and with which they themselves are not necessarily familiar. It should also show that when a plant is carefully worked out with a definite purpose in view, it is not at all impossible to obtain definite guarantees on different equipment, which, when combined, will produce the over-all result that the purchasing company had in mind at the time of placing the contracts.

National Association of Corporation Schools

The National Asssociation of Corporation Schools, Irving Place at 15th St., New York, is conducting a campaign for increased membership.

The prime purpose of the association is to bring into one cohesive organization all of the large business institutions of the country in order that, by analysis and comparison of methods adopted by the various members, the most effective plans may be devised for educating and training employees for their work. The organization has been in existence four years and is proving a valuable aid and a big factor in the educational plans of its 105 member corporations, hence the belief that the work should be extended. Dr. Steinmetz is quoted as saying that "Vocational training is the most important industrial problem in this country. . . . The superiority of America in the electrical industry over all other countries is due largely to educational development and coöperation between the manufacturing companies and educational institutions."

It is this specialized training in retail and general selling, in the trades and in office work that the National Association of Corporation Schools was organized to promote. It is an association of corporations for corporations to help them in the specialized education of their employees. It covers other aspects of business efficiency also, and reports have been made on employment plans, safety and health, vocational guidance, public-school education, profit sharing, insurance and pension plans. Thus it has become a forum for the interchange of ideas on the principal factors that make for increased efficiency of the working force.

Some executives, after learning of the work of the association, have made the objection against taking membership, "We have no school." The answer is, "Neither had half the present members when they joined the association." They took membership because of an appreciation of the part education is to play in the industrial life of the future. They are learning through the association how to proceed—what to teach, how to teach it, what pitfalls to avoid. Specialized training of their employees must come. The indications are patent to every executive. These corporations are forehanded and, if not conducting schools now, are preparing for the inevitable future.

A booklet giving details of the work and methods with a roster of members may be had by addressing the secretary, F. L. Devereux, 195 Broadway, New York City.

Preferential Coal Shipments

Requests to coal operators issued by the United States Fuel Administration establish the order of preference in which coal needs are to be filled and provide for preferential shipments for thirty days.

The requests are designed to insure the fulfilling of the requirements of those coal users whose activities are essential to the military and economic efficiency of the nation in the conduct of the war. They are not in the form of direct orders of the Fuel Administrator, but all producers are asked to coöperate in meeting these requests.

The following request was directed to all operators in Ohio, Michigan, Kentucky, Illinois, Indiana, Alabama, Tennessee, Colorado and Oklahoma:

Subject to compliance with orders heretofore issued by the Fuel Administration for preference in shipments for certain specified purposes, the Fuel Administration requests that you give preference in shipments for the next thirty days on Government orders, railway fuel, domestic requirements, public utilities and munition plants. It is necessary in the present situation to give preference in shipments as requested, and we solicit and thank you in advance for your coöperation in this direction.

We will appreciate it if you will advise the Fuel Administration of any free tonnage you have available which we may call on you to ship for emergency requirements.

All operators in Pennsylvania and Kentucky were requested in a similar form to give preference in shipments for the next thirty days on Government orders, railway fuel, domestic requirements, public utilities, steel plants, byproduct coke ovens and munition plants. All operators in West Virginia and Virginia were requested to give preference to shipments for thirty days on Government orders, railway fuel, tidewater shipments for New England, domestic requirements, public utilities and munitions plants.

The requests cover practically all the coal production of the country outside of the Rocky Mountain coal districts. The Rocky Mountain output is largely consumed in the localities where it is produced.

Use of Electricity Restricted in Province of Turin, Italy

In view of the amount of electric power required for the production of war material, and the limited quantity of fuel available for operating the several generating stations for electricity, a decree has been issued by the Prefect of Turin restricting the use of such energy, according to *Commerce Reports*. As a result, the illumination in this province is reduced by 50 per cent. Both day and night electric illumination as an advertisement is prohibited in front of all theaters, motion-picture houses or shop windows, and similar advertising for other purposes is forbidden. The operation of several of the less-important lines of street cars is suspended during the war. The use of all household electrical apparatus is prohibited, with the exception of the electric flatiron, which may be used only from 8 p.m. to 7 a.m. Illumination for stairways and halls is reduced to lamps of 16 cp. All theaters, motion-picture houses, concert halls, cafés and other places of amusement are to remain closed during the day, with the exception of Sundays and holidays, and motion-picture performances are permitted only from 7:30 to 11 p.m. Small shops may use intermitent electric power from 4 to 8 p.m.

These restrictions have been imposed in order to economize and avoid a waste of power such as previously took place in shops, theaters, etc., where lights were kept burning all day, and thus reserve electric energy for the many factories of this district.

British Retail Coal Prices Order

Under the retail coal prices order, 1917, dated Sept. 11, which has been made by the board of trade at the instance of the controller of coal mines, maximum retail prices of house coal throughout the United Kingdom are now to be definitely fixed. The basis on which the maximum prices are to be arranged by the local authorities is contained in the order, Article I of which provides that the net profit from sales of coal delivered by road vehicle from a depot or wharf or railway siding, in lots of 1 ton or over, shall not exceed 1s. (24c.) per ton. This net profit includes all interest charges and salaries to owners, partners, and directors of the business, but not remuneration to owners of small businesses in respect of manual labor or clerical work performed by them. The order further prescribes how the prices for sales of smaller lots than 1 ton are to be fixed by reference to the maximum prices of lots of 1 ton or over. The local authorities are to meet the local coal merchants, and, after investigation of the figures submitted by them, are to publish in the local press lists showing the prices chargeable under the order for the various classes of coal sold in the district for household purposes. When prices have been so published by the local authority, such publication is to be conclusive evidence that the prices comply with the provisions of the order.

To save the local authorities the trouble of investigations into costs in every locality, a detailed memorandum has been forwarded to each local authority embodying the results of a careful examination made by the controller of coal mines of the position in a large number of localities in different parts of the country. As a result of this examination it has been ascertained that in general (except in the case of sea-borne coal) retail prices should not exceed the prices in operation in the 12 months prior to the war by more than 6s. 6d. to 7s. 6d. ($1.58 to $1.83) per ton, the lower of these figures applying more particularly to towns in the neighborhood of colliers. In certain cases, however, the increases over pre-war prices are less than these amounts, and in such cases there should be no increase in the present prices. On the other hand, in other districts an increase of more than 7s. 6d. per ton over pre-war prices may, owing to special circumstances, be justifiable.—*Commerce Reports.*

The Grinding Wheel

The success of the modern grinding wheel, says R. G Williams, in "Proceedings of the American Electrochemical Society," May 2-5, 1917, is dependent to a very large degree upon the product of the electric furnace (namely, artificial abrasives), these having almost entirely supplanted the formerly widely used emery. Artificial abrasives are of two kinds or groups—the aluminous group and the carbide of silicon group.

The crude abrasive is delivered from the electric furnace to the grinding-wheel factory and broken up into lumps that will pass through a 6-in. ring and smaller. The first step in the production of grain to be used in grinding wheels and other products such as oilstones, rubbing bricks, refractories, etc., is to pass the material through powerful crushers equipped with manganese-steel jaws. This operation reduces the material to small lumps. It is further reduced from small lumps to grains by passing through a series of rolls, each pair being set to crush smaller than the preceding. In this way a range of sizes from very coarse to very fine is produced. Some abrasives contain an appreciable amount of magnetic material detrimental to the manufacture of wheels. This is removed by means of a magnetic separator. The material is further freed from extraneous matter by a washing process. It is then sized by passing through screens of varying mesh and for the very fine sizes, referred to as "flour," by a sedimentation process.

All grinding wheels are composed of two main constituents —the abrasive and the bond, or the substance by which the particles of abrasive are held together. The commercial method of classifying grinding wheels is by the kind of bonding material used. The most widely used type of wheel is that bonded by a ceramic process, in which the mixture of abrasive and a clay bond are baked in a kiln like pottery ware. Such wheels are known as vitrified wheels. Another type of bonding where elasticity is sought is represented by vulcanized wheels. The operation of vulcanizing the mixture of abrasive rubber and sulphur is similar to that employed in vulcanizing any other product. The wheels, which have been molded approximately to size, are finally provided with a lead center and trued to size with a diamond tool.

New Publications

PRACTICAL ELECTRICITY. By Terrell Croft. Published by McGraw-Hill Book Co., Inc., New York City, 1916. Cloth; 5½ x 8 in.; 646 pages, 548 illustrations. Price, $2.50.

Heretofore the opening chapter in most books on elementary electricity and magnetism treated either static electricity or magnetism, but in this, Mr. Croft's latest book, he has broken away from the established precedent and has gone back to the present accepted theory on what matter and electricity are. The opening section, "Matter and the Electron Theory," to which 24 pages are devoted, is probably the most remarkable attempt ever made to present the electron theory in a practical way, so that it may be understood by a student of elementary electricity and magnetism. This theory is made use of in other parts of the book, where desirable, in explaining the theory of magnetism and electricity. In this feature the book is of interest not only to the student of elementary electricity, but also to the more advanced reader.

The work is divided into 52 sections, of which ten are devoted to magnetism, electromagnetism, construction of electromagnets and their application. Seven sections are given over to the fundamental ideas concerning electricity, electromotive force, electric current, resistance, Ohm's law, and the generation of electrical energy. The subjects of storage batteries, primary cells, and electrolysis are treated in four sections. Electromagnetic induction is discussed in six sections. Principles of the electric generator, construction of direct-current generators, their voltage, rating, efficiency and characteristics, are considered in eight sections. Four sections are devoted to the direct-current motor. In eleven sections the subjects of characteristics of alternating-current circuits, principles and construction of alternating-current generators, power and power factor, polyphase circuits and systems, etc., are treated. One section is devoted to transformers and one to three-wire distribution systems.

These sections are divided into 869 subsections. Each subsection is given a title and number and is indexed according to its number and title, 14 pages being devoted to this index. The work probably represents the greatest amount of labor ever devoted to illustrating any single volume on electricity and magnetism, and in so far as possible the pictures have been so made as to tell their own story. Many of the illustrations used to explain the theory of electricity are radical departures from those found in other books of this character. Numerous examples are worked out throughout the book showing the application of the 290 expressions given, for obtaining different values in electricity and magnetism.

The author in his preface states that "the primary object of the book is to present the fundamental facts and theories relating to electricity and its present-day applications in a straightforward, easily understood way for study by any man of little mathematical training, who desires to acquire working knowledge of the subject. Secondarily, the book was designed for university graduates who desire a medium whereby they can with minimum effort review, refresh and reconstruct in line with modern theory and practice their concepts of electricity and magnetic phenomena." These objects the author seems to have admirably accomplished, and the work is one that should be of value to almost everyone who is interested in the subject of electricity and magnetism.

INVESTIGATION OF PIPE CORROSION

An Investigation of Pipe Corrosion is the title of Bulletin No. 30, issued by the A. M. Byers Co., of Pittsburgh, Penn. The investigation was prompted by local agitation on the part of property owners, who charged that chemicals were being used in the water-filtration plants which destroyed the piping to such an extent that not even brass was immune. This subject was taken up by the Pittsburgh Board of Trade, and a report rendered which showed that no chemicals were used which could in any way be held responsible for the trouble, but the thought was expressed that the city should not be held responsible for the fact that much pipe of inferior quality had come into use in recent years.

In order to determine the life of pipe under varying conditions of service, Thomas F. Payne, a sanitary engineer, of Pittsburgh, was commissioned by the A. M. Byers Co. to make a house-to-house canvass of buildings, "with a view to ascertaining all the pertinent facts which might aid property owners in meeting the rust question in the most efficient manner." After several unsuccessful attempts to obtain accurate data from private residences and other buildings, it appeared that apartment buildings offered the best field for investigation, and 125 such buildings, all in Pittsburgh, were investigated. A tabular statement gives the name and location of each apartment building investigated, the year of its erection, the length of time which both hot- and cold-water lines of brass, steel and wrought iron have been in service, and their present condition.

The rusting out of pipes is one of the prolific sources of trouble for the power-plant engineer, and he will welcome any research work on the subject. The investigation showed the corrosion to be most severe in hot-water mains (exposed basement piping), and the recommendation is therefore made that pipe one size larger than that used in regular practice be used. The large size, having a greater thickness and larger bore, would not so easily rust through or become stopped up with rust. The hot-water risers, which are usually concealed, proved to have a much larger life than the basement mains. It is, therefore, a question whether the practice of specifying brass pipe for risers, and iron or steel for mains, might not better be reversed. Brass pipe in this investigation did not show up as well as might be expected, and many complaints were heard on that account.

It appeared from the investigation that the pipe lasted a little longer where an automatic water heater was used. This undoubtedly is due to the possibility of maintaining a lower temperature of the water than with a heater not having thermostatic control, for corrosion increases with the temperature, reaching its maximum between 140 and 170 deg. F. Temperatures from 115 to 130 deg. F. are therefore to be recommended wherever they will serve the purpose.

Personals

Charles A. Cahill, for a number of years associated with the consulting-engineering firm of T. S. Watson & Co., Milwaukee, Wis., and prior to that superintendent of motive power for the Milwaukee Electric Railway and Light Co., has opened offices of his own at 1426 First National Bank Building, Milwaukee, where he will practice consulting engineering with a special view to industrial and power-plant efficiency problems.

R. N. Ehrhart, formerly chief engineer of the condenser department of the Westinghouse Electric and Manufacturing Co., resigned to take up his duties as president and consulting engineer of the Sedar Coal Co., of Pittsburgh, Penn. He has been retained as consulting engineer by several engineering firms and by his old employers. He will also engage in consulting work for power-plant equipment, with special reference to turbine and condenser installations, at 217 Vine St., Edgewood, Pittsburgh.

Engineering Affairs

The Forty-third Annual Convention of the National Marine Engineers' Beneficial Association will be held at Baltimore, Md., during the week of Jan. 21. The Belvedere Hotel will be the headquarters. Owing to the crowded conditions at Washington the convention will not be held in that city, as heretofore.

The American Association of Engineers has organized a local chapter in New York City; headquarters have been established at 220 West 42nd St. Temporarily, meetings are being held at the Hotel McAlpin, Broadway and 33rd St. Up to date these meetings have been mainly devoted to the work of the organization. This is now nearing completion and the society will shortly be in a position to engage in constructive work. The last meeting was held on Dec. 17.

Hoboken Association No. 5, N. A. S. E., held its sixteenth annual entertainment and ball on Wednesday, Dec. 5, at Grand View Hall, Jersey City, N. J. The large hall was comfortably filled. The entertainment consisted of the following numbers: "Star Spangled Banner"; Elizabeth Clave, soprano; Amy Allen, contralto; Mae Sims, popular songs; Elmer Ransom, magic; Bob Jones, lyric tenor; Monroe Silver, parodies; Billy Murray, of Jenkins Bros., up-to-date songs; Jack Armour, of "Power," humorous stories. Dancing concluded a pleasant social occasion. The officers of No. 5 are: John J. Fagan, president; Arthur Ward, vice president; William Murdtor, corresponding secretary; Edwin Snook, recording secretary; Arthur Dix, financial secretary; William Crary, treasurer; John Crary, conductor; William David, doorkeeper.

The Stationary Engineers' Association of Greater New York held its fifth annual entertainment and ball at Amsterdam Opera House, on Saturday, Dec. 8. Taking into consideration the inclemency of the weather, the attendance was surprisingly large. A dancing program of 24 numbers was preceded by an enjoyable entertainment. The hall was tastefully decorated. The officers of the association include W. H. Fletcher, president; Thomas Leahy, vice president; D. Salmon, secretary; T. McGarry, treasurer. The general committee comprised Patrick Cody, W. H. Mason and A. F. Swanson.

The International Union of Steam and Operating Engineers, Local No. 20, held its eighteenth annual entertainment and ball at the New Star Casino, New York City, on Saturday, Dec. 8. While the attendance was not up to the high standard of these events, owing to the stormy night, a pleasant evening was spent. An enjoyable vaudeville of eight numbers preceded a lengthy dancing program. The officers of No. 20 are: William J. Schmitt, president; Edward J. Hanley, vice president; Patrick Phillips, recording secretary; John J. McDonald, financial secretary; Bernard Cassidy, treasurer; James Gardner, conductor; Eugene O'Connell, guard; Edward McDonald, sergeant-at-arms; Michael Murphy, business agent. Patrick F. Stratford was the floor manager, assisted by Frank Stein.

Business Items

The Roberts Steam Specialty Co., of Cleveland, Ohio, recently incorporated under the state law, is engaged in the manufacture of high-grade steam specialties, of which the "Roberts Safety Water Column" is the leader. The president of the company is F. Y. Roberts, who has had long experience in the safety water-column business.

Miscellaneous News

A Committee To Act As Consulting Engineers to the Bureau of Mines in matters relating to coal conservation and publicity has been appointed by Dr. Ira N. Hollis, president of the American Society of Mechanical Engineers, as follows: Prof. L. P. Breckenridge, chairman; R. H. Fernald, C. R. Richards, David Moffat Myers, Carl Sholz, E. L. Edgar, O. P. Hood, secretary.

Fuel Administrator Garfield has formally approved plans of the Coal Shippers' Terminal Pool Association for establishing terminal coal pools in the Central West to facilitate handling of the coal supply. The plan contemplates uniform pooling arrangements under the central executive and advisory committee of the pool association wherever pools are established with the approval of the Fuel Administration.

The Big Dam of the Oregon Power Co. at Coppo, Calif., on the Klamath River, is finished and the reservoir is now being filled, an operation that will require between three and four weeks, with a flow of 1300 sec.-ft. This dam is one of the largest engineering feats in that section of the country and has been under construction for three years. It backs the water up for five miles in the river. A force of three hundred men has been at work almost all the time since it was begun, and the total cost of the improvement will approximate $1,500,000. The bed of the river was excavated to a depth of 125 ft. in order to get a solid foundation; the dam rises to the same height above the surface and is 95 ft. across at the base and 500 ft. at the top. The impounded water is sufficient to develop 26,000 hp., and as much more will be developed later on. The power generated will be used in the various projects of the corporation, and by constructing a similar dam just below the present structure, it is planned eventually to bring the total up to 103,000 hp. It is estimated that the cost per horsepower for the Coppo improvement is $78, which is one of the cheapest in the West.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Dec. 14, 1917	One Year Ago	Dec. 14, 1917	One Year Ago
Buckwheat	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Dec. 14, 1917	One Year Ago	Dec. 14, 1917	One Year Ago
Clearfields	.....	$3.00	.....	$4.25—5.00
Cambrias and Somersets	.....	3.10—3.85	.....	4.60—5.40

Note—Bituminous not on market.
Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago; on cars Boston price is $8.50—8.75.
*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Dec. 14, 1917	One Year Ago	Dec. 14, 1917	One Year Ago
Pea	$5.05	$4.00	$5.80	$5.25—5.75
Buckwheat	3.95—4.65	2.75	5.75—6.00	4.25—4.50
Rice	3.40—3.61	2.20	4.50—4.75	2.50—2.75
Barley	2.90—3.15	1.95	3.00—3.20	2.20—2.60
Boiler	3.15—3.40	2.20	.....	.....

Bituminous smithing coal, $4.50—5.25 f.o.b.
Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate)	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Dec. 14, 1917	One Year Ago	Dec. 14, 1917	One Year Ago
Buckwheat	$3.15	$2.00	$3.75	$2.90
Rice	2.65	1.25	3.65	2.15
Boiler	2.45	1.10	3.55	2.00
Barley	2.15	1.00	2.40	1.90
Pea	3.75	2.80	4.65	3.70
Culm	1.25	....	....	....

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Screened sizes	$2.65—2.80	$3.10—3.25
Mine-run	2.40—2.55	2.85—3.00
Screenings	2.15—2.30	2.60—2.75

Smokeless Coals	So. Illinois, Pocahontas, Pennsylvania and West Virginia	Hocking, East Kentucky and West Virginia Splint
Steam lump	$2.60—2.80	$2.85—3.25
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.30	2.35—2.75

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Dec. 14, 1917	One Year Ago	Dec. 14, 1917	One Year Ago	Dec. 14, 1917	One Year Ago
6-in. lump	$2.65	$3.25	$2.65*	$3.25	$2.65	$3.25
2-in. lump	2.65	3.25	2.65*	3.25	2.65	3.25
Steam egg	2.65	3.25	2.65*	3.25	2.65	3.25
Mine-run	2.40	3.25	2.40*	3.25	2.40	3.25
No. 1 nut	2.65	3.25	2.65*	3.25	2.65	3.25
2-in. screen	2.15	3.25	2.15*	3.25	2.15	3.25
No. 5 washed	2.15	3.25	2.15*	3.25	2.15	3.25

*Strike.
Williamson-Franklin rate St. Louis, 87½c.; other rates, 72½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ala., Gadsden—The Davis-Alcott Hosiery Mills are in the market for the immediate delivery of electric motors, shafting, etc., at its plant.

Calif., Hanford—The People's Ditch Co. plans to install an electric-lighting and power plant at the headgate of its irrigation system.

Ill., Chicago—Chicago Surface Lines, 105 South La Salle St., is having plans prepared for the erection of several units, including a power house on Clark St. and Schreiber Ave. H. B. Fleming, Ch. Engr.

Ill., Vienna—J. J. Oelrich has petitioned the City Council for a franchise to build and operate an electric-lighting and power plant.

La., New Orleans—The Machinery Exchange Co., 4201 Bienville St., is in the market for 2000 hp. boilers, a 1500-hp. condensing engine and other machinery.

Mass., New Bedford—The Union Street Railway Co. is having plans prepared by G. M. Hope Eng. Co., Engrs., 185 Devonshire St., Boston, for a 88 x 115-ft. brick and reinforced-concrete power plant. Noted Sept. 25.

Mont., Great Falls—The Montana Power Co. plans to build a substation in the downtown section. Estimated cost, $150,000. J. R. Hobbins, Mgr.

Mont., Hot Springs—C. Smith and F. E. Campbell plan to build a power plant here.

N. J., Jersey City—The Board of Freeholders, Hudson County, plans to enlarge and improve the county electric-lighting plant.

N. Y., Buffalo—The Buffalo Union Furnace Co., Katherine St., has had plans prepared for alterations and addition to its power house. Estimated cost, $14,000.

N. Y., Buffalo—The Donner Steel Co., 475 Abbott Rd., plans to build an addition to its power house.

N. Y., Canaseraga—The Canaseraga Heat, Light and Power Co., Inc., has petitioned the Public Service Commission for permission to build and operate an electric-lighting plant.

N. Y., New York—(Borough of Manhattan)—The New York Edison Co., 666 1st Ave., is having plans prepared by G. F. Kiess, Archt., 30 East 5th St., for the erection of a new 1-story, 40 x 63-ft. brick addition to its transformer station at Park Ave. and 129th St. Estimated cost, $15,000. Noted Oct. 30.

N. D., Crary—J. W. Ebert has been granted a franchise for the erection of an electric-lighting plant.

Ohio, Carrollton—The Van Kirk Coal Co. plans to install a new electric system to operate its mine and supply light to the village of Delroy.

Ohio, Cleveland—The Standard Brewing Co., 5801 Train Ave., plans to remodel its boiler house. Estimated cost, $12,000.

Okla., Laverne—City voted favorably on a $13,000 bond issue for the erection of an electric-lighting plant.

Okla., Okmulgee—The Omaha Lead and Zinc Co., recently incorporated with $350,000 capital stock, is in the market for mining and power-plant equipment. E. J. Dick, Okmulgee, one of the incorporators.

Ore., Astoria—The Pacific Power and Light Co., Spalding Bldg., Portland, has petitioned the City Council for permission to build a small substation on Taylor Ave., here. J. C. Martin, Engr.

Penn., Bridgeport—The Philadelphia & Reading Ry., Reading Terminal, Philadelphia, plans to erect a 1-story engine and power house here. S. T. Wagner, Ch. Engr.

Penn., Pittsburgh—The Miller-Owan Electric Co., 217-19 1st Ave., has had plans prepared by C. D. Cooley Co., Archt., Century Bldg., for the erection of a 1-story, 40 x 200-ft. addition to its plant. Estimated cost, $40,000.

Tenn., Coal Creek—The Black Diamond Coal Co., 707 Empire Bldg., Knoxville, plans to install a new alternating-current power plant at its mine here.

Tenn., Fountain City—City is considering plans for the installation of an electric-lighting system.

Tenn., Knoxville—The J. G. Duncan Co., 308 Jackson St., is in the market for a double-cylinder, double-drum hoisting engine and boiler, 8½ x 10-in. cylinders, about 30 hp., also 5½ x 7 in. or 6½x8 in. for similar engine.

Tex., Amarillo—The City Commission is considering the erection of an electric-lighting plant for which a bond issue of $200,000 will be voted on soon.

Wash., Renton—Chicago, Milwaukee & St. Paul R.R., White Bldg., Seattle, plans to build a reinforced-concrete substation. Estimated cost, $75,000. C. F. Loweth, Chicago, Ch. Engr.

W. Va., Cameron—City Council granted W. V. Smith a franchise to build and operate an electric-lighting plant here.

W. Va., Clute—The Hawley Coal Co. plans to build a power plant at its works here. W. I. Hawley, Bluefield, Pres.

W. Va., St. Marys—St. Marys Light and Power Co. is having plans prepared by R. H. Adair, Arch., 501½ Juliana St., Parkersburg, for a new 1-story, 50 x 64-ft. electric-lighting plant.

Ont., Chatham—T. H. Taylor Co. is in the market for a complete outfit of Jones underfeed stokers for 2 boiler installations including engine, fan, etc.